

# Utah Department of Transportation



## **2002 Standard Specifications FOR ROAD AND BRIDGE CONSTRUCTION**

**U.S. Standard Units (Inch-Pound Units)**

**Change Three**

**March 25, 2003**

# Memorandum

UTAH DEPARTMENT OF TRANSPORTATION

**DATE:** March 25, 2003

**TO:** Holders of Hard Copy of Standard Specifications

**FROM:** Barry Axelrod, CDT  
Standards and Specifications

**SUBJECT:** Standard Specifications Distribution, Change 3, dated March 25, 2003

A new Index and updated Standard Specifications are attached. Please take the following action with respect to the attached pages. When done post this page in front of your book.

## REMOVE

Index Of Standard Specifications  
Listing of Revised Standard Specifications  
01355 (dtd July 3, 2002)  
01721 (dtd July 3, 2002)  
02222 (dtd July 3, 2002)  
N/A  
02316 (dtd July 3, 2002)  
02455 (dtd July 3, 2002)  
02721 (dtd August 29, 2002)  
02741 (dtd August 29, 2002)  
02744 (dtd July 3, 2002)  
02745 (dtd July 3, 2002)  
02785 (dtd December 19, 2002)  
02892 (dtd August 29, 2002)  
02896 (dtd July 3, 2002)  
16525 (dtd August 29, 2002)

## INSERT

Index Of Standard Specifications  
Listing of Revised Standard Specifications  
01355 (dtd February 27, 2003) (Revised)  
01721 (dtd February 27, 2003) (Revised)  
02222 (dtd February 27, 2003) (Revised)  
02224 (dtd February 27, 2003) (New)  
02316 (dtd February 27, 2003) (Revised)  
02455 (dtd February 27, 2003) (Revised)  
02721 (dtd February 27, 2003) (Revised)  
02741 (dtd February 27, 2003) (Revised)  
None - Section deleted  
02745 (dtd February 27, 2003) (Revised)  
02785 (dtd February 27, 2003) (Revised)  
02892 (dtd February 27, 2003) (Revised)  
02896 (dtd February 27, 2003) (Revised)  
16525 (dtd February 27, 2003) (Revised)

If you are in need of electronic copies of any of the Standard Specifications please refer to the Standards and Specifications Web page on the Internet or the Shared Data drive (for UDOT employees with access). The web address is <http://www.dot.utah.gov/esd/esdmenu3.htm>. From there select the **2002 Standards** or **Electronic Plan Room Specifications and Information** links.

A copy of the Standard Specifications in Adobe pdf format can be found at <http://www.udot.utah.gov/esd/2002Standards/Specs/PDFFiles/UDOT2002Specs.pdf>. This file will remain static for the remainder of 2003. Changes to the Standards will be posted separately.

If you have any questions or problems with the electronic files contact me at (801) 964-4570 or by email at **baxelrod@utah.gov**.

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## **Listing of Revised Standard Specifications**

### **Change One**

Revised August 29, 2002

- Section 00570 Articles 1.2 A 69, A 71 b (deleted)
- Section 00727 Articles 1.1 D; 1.5 B; 1.9; 1.10; 1.16 B, C; 1.18 B
- Section 01574 Articles 1.2 B
- Section 02721 Articles 1.2 D (added), H (replaced), I (deleted); 1.6 B1; 2.1 A Table 3; 3.2 C
- Section 02741 Articles 3.8 E 2 a, b
- Section 2821 Articles 3.1 A
- Section 02892 Articles 1.5 A, B
- Section 02936 Articles 1.4; 1.5 C
- Section 03152 Articles 1.2 P, Q; 2.2 A, B
- Section 05120 Articles 1.4 A (deleted), 3.3 A
- Section 16525 Articles 1.6 A, B

### **Change Two**

Revised December 19, 2002

- Section 01561 Article 3.1 A
- Section 02075 Article 2.7 A
- Section 02372 Article 2.1 A 4
- Section 02455 Article 3.3 B 2
- Section 02785 Article 3.2 C
- Section 02861 Article 3.3 A
- Section 03055 Articles 1.2 P (inserted), 2.3 B, 2.4 (deleted), 2.7 A 1 a-e (added), 2.7 B 2 (added), 2.8 A 1 a, 2.8 A 2 (deleted), 2.9 A3, 3.2 A Table, 3.2 C, 3.7 A 3, 3.8 C 1, 3.9 A-B, 3.10, 3.11 B 1, 3.11 B 3
- Section 07922 Article 2.1 Table 1

## **Change Three**

Revised February 27, 2003

Section 01355 Article 1.3 A 3

Section 01721 1.4 C deleted and moved to Measurement and Payment document

Section 02222 Changed title from Site Demolition-Pavement to Site Demolition - Concrete, A, 3.2 Title, 3.2 A

Section 02224 New Specification

Section 02316 1.2 A, D, I added, 1.3 added, 1.7 B, C, D, E, F, G added, 3.9 A added

Section 02455 3.3 B 2 (corrected error from change two)

Section 02721 1.2 Related Sections added, 1.3 H, I, and J added, 1.7 B, 1.7 F deleted, 2.1 B added, 2.2 deleted, 3.1 Title changed, 3.2 B reference added, 3.2 E added

Section 02741 1.4 C6a added, 1.4 H, Table 3, 2.4 A, 2.4 C, Table 9, 2.5 B 1-3, 2.5 B 4 added, 2.5 D, 3.1 A1 deleted, 3.2 C3 added, 3.7 D1, 3.9 B4, 3.9 B5 added, 3.9 E note added

Section 02744 Entire Section deleted

Section 02745 1.4 A9

Section 02785 1.2 C and D added

Section 02892 Added Articles, 1.3 N, O, Y, 1.5 D, 2.4 I, 2.5 C, D, E, 2.6 B3 - B6, 2.6 C, 2.16, 2.17, 3.11 and Revised Articles 3.5 F and Table Number, 3.5 G and Table Number

Section 02896 2.1 A, B and 3.1 A drawing number corrected

Section 16525 1.2 H

## **SECTION 01355**

# **ENVIRONMENTAL PROTECTION**

## **PART 1 GENERAL**

### **1.1 GENERAL PROVISIONS**

- A. Comply with all Federal, State, local laws and regulations, and the provisions of this Section controlling environmental pollution.
- B. Prevent pollution of streams, lakes, ponds, and reservoirs with sediment, fuels, oils, bitumens, chemicals, or other harmful materials and pollution of the atmosphere from particulate and gaseous matter.
- C. Incorporate Best Management Practices to prevent hazardous material releases by segregating wastes, providing secondary containment and having spill kits and absorbents on hand.

### **1.2 HAZARDOUS MATERIAL - DISCOVERED DURING CONSTRUCTION**

- A. Immediately suspend work in the area and notify the Engineer if abnormal conditions are encountered or exposed during construction that indicates the presence of a hazardous material, toxic or hazardous waste.
  - 1. Treat the conditions with extreme caution.
  - 2. Abnormal conditions include, but are not be limited to, the following: presence of barrels; buried storage tanks; above ground tanks; obnoxious odors; excessively hot earth; stained and discolored soils; smoke; unidentifiable powders, sludges, pellets; or any other condition that could be a possible indicator of hazardous material, toxic or hazardous waste.
- B. Resume operation in this area when directed by the Engineer. Continue working in other areas of the project, unless otherwise directed by the Engineer.
- C. Dispose of the hazardous material, toxic or hazardous waste under the requirements and regulations of the Utah State Department of Environmental Quality and United State Environmental Protection Agency.
  - 1. Perform by change order necessary work required to dispose of these materials.

2. Disposition of waste materials requiring special procedures by certified personnel will be arranged by the Department with qualified persons to dispose of the material.

### **1.3 HAZARDOUS MATERIAL - CONTRACTOR CAUSED**

- A. Notify the Engineer and the Department of Environmental Quality of spills of petroleum based products or hazardous waste if the release would meet the definition of a hazardous waste as defined in 40 U.S. Code of Federal Regulations 261.
  1. Notify the Engineer immediately after the discovery of the spill.
  2. Notify the Department of Environmental Quality (DEQ) in writing within 5 calendar days of the discovery.
  3. Notify the DEQ in accordance with R315.9 of Utah Administrative Code. 24-hour phone number: (801) 536-4123.
- B. Dispose of spilled material according to the requirements and regulations of the Utah State Department of Environmental Quality.
- C. Pay for the required clean-up operations.

### **1.4 LIVE STREAMS**

- A. Ford or work in live streams or any live body of water (live water) only with approval from the Utah Division of Water Quality and Utah Division of Water Rights. Do not operate mechanized equipment in live water unless provided for in the Contract. Minimize stream siltation.
- B. Use a dike or barrier to separate work areas or pits located in or adjacent to streams from the main stream. Prevent sediment from entering adjacent streams.
- C. Treat water used to wash aggregate or water from other operations that produce sediment by filtration, settling basins, or other methods that reduce sediment concentrations to the level of the stream or lake into which it is discharged.

### **1.5 OPEN BURNING**

- A. Not permitted along highway rights-of-way without approval orders from the Executive Secretary of the Utah Division of Air Quality.

## 1.6 ABRASIVE BLASTING - VISIBLE EMISSION STANDARDS

### A. **Visible Emission Standards:**

1. Abrasive blasting outside of Weber, Davis, Salt Lake and Utah Counties: Do not discharge into the atmosphere an opacity darker than 40 percent for a period or periods aggregating more than 3 minutes in any 1 hour.
2. Abrasive blasting inside Weber, Davis, Salt Lake or Utah Counties where the performance standards in this article, paragraph C are used: Do not discharge into the atmosphere an opacity darker than 20 percent for a period or periods aggregating more than 3 minutes in any 1 hour.
3. Abrasive blasting inside Weber, Davis, Salt Lake or Utah Counties where the performance standards in this article, paragraph C are not used: Do not discharge into the atmosphere an opacity darker than 40 percent for a period or periods aggregating more than 3 minutes in any 1 hour.

### B. **Visible Emission Evaluation Techniques:**

1. Read emissions from unconfined blasting at the densest point of the emission after a major portion of the spent abrasive has fallen out. Densest point will be between 6 feet and 25 feet from the impact surface of the abrasive blasting nozzle.
2. Judge emissions from unconfined blasting employing multiple nozzles as a single source unless each nozzle meets the emission and performance standards.
3. Read emissions from confined blasting at the densest point after the air contaminant leaves the enclosure.

### C. **Performance Standards:** Any one of the following may be used as a performance standard.

1. Confined blasting
2. Wet abrasive blasting
3. Hydroblasting
4. Unconfined blasting using abrasives defined below:
  - a. Before blasting, the abrasive will not contain more than 1 percent by weight material passing a #70 U.S. standard sieve.
  - b. After blasting, the abrasive will not contain more than 1.8 percent by weight material 5 micron or smaller.
  - c. Abrasives reused for dry unconfined blasting are exempt from the requirements of “after blasting,” but must conform with the requirements of “before blasting” above.

- D. **Abrasive Certification:** Sources using the performance standard for unconfined blasting must demonstrate they have obtained abrasives from persons who have certified (submitted test results) to the Utah Air Quality Executive Secretary at least annually that such abrasives meet the requirements outlined above for abrasives.

## 1.7 NOISE AND VIBRATION CONTROL

- A. Identify haul routes and percussive noise sources that annoy sensitive receptors and prevent these sources from becoming a problem.
- B. Definitions and Standards - Use terminology that meets applicable American National Standards Institute (ANSI) publications and commonly accepted practices of acoustical measurements.
1. Receptor - An occupied residential dwelling, church, hospital, school, outdoor stage, or structure confining other noise sensitive activities.
  2. Noise Sensitive Zone - The land enclosed within a 1500 foot radius circle of any receptor.
  3. Sound Level - The total sound pressure level from all concurrent construction activities related to the subject project, as measured with a sound level meter using the A-weighting network (ANSI S1.4). The standard notation is dB(A) or dBA.
  4. Percussive Noise - Short burst(s) of banging or clattering noise including but not limited to blasting, pile driving, and jack-hammering.
- C. Prohibitions - Suspend construction work under the following conditions:
1. Construction activity in a noise sensitive zone causes the sound level within 10 feet of the nearest receptor to exceed: 95 dBA in daytime (7 a.m. - 9 p.m.), or 55 dBA in nighttime (9 p.m. - 7 a.m.)
  2. A noise sensitive zone on Sundays and State Holidays.
  3. Project related construction noise or vibration does not meet specifications. Suspend the portion of construction work responsible for the problem until noise is reduced to the required noise standards.
- D. Compliance:
1. Follow all local noise ordinances, except where a variance in accordance with local regulations has been granted.
  2. Local noise ordinance variance does not provide an exemption from complying with the requirements of this article, paragraph C.
- E. Percussive Noise: Notify the Engineer at least 2 weeks in advance of any percussive noise activity that is expected to exceed the provisions of this article, paragraph C. Coordinate with the Engineer to notify the public.

## **1.8 ENVIRONMENTAL CLEARANCE BY THE CONTRACTOR**

- A. Obtain and provide the following environmental clearances before beginning project activity when adding or selecting any ground- or resource-disturbing features such as material (gravel, borrow or waste) sites, equipment staging sites, office sites, water lines, holding ponds, etc., not provided in the Contract:
1. Cultural and Paleontological - Initiate consultation concerning proposed additional feature(s) with a Department staff archeologist. (hiring a private archeological subconsultant and coordination with the Utah State Historic Preservation Office may be required.) The Department staff archeologist provides clearance to the Contractor via written notification. See this Section, Article 1.9, Discovery of Historical, Archeological, or Paleontological Objects.
  2. Threatened and Endangered Species: Obtain written clearance from the U.S. Fish and Wildlife Service.
  3. Wetlands: Obtain written clearance from the U.S. Army Corps of Engineers.
  4. Floodplains - Initiate consultation concerning the proposed additional feature(s) with the Region Hydraulics Section. Subsequent coordination with the Federal Emergency Management Agency (FEMA) may be required. Verification of non-interference by the Contractor with a floodplain or compliance with FEMA guidelines will be provided to the Contractor by the Region Hydraulic Engineer.
  5. Prime, Unique, and Important Farmland - Initiate consultation concerning the proposed additional feature(s) with the farmland specialist with the Region's Environmental Engineer. Subsequent coordination by the Contractor with the U.S. Natural Resources conservation service may be required. The Region provides written clearance to the Contractor.
  6. Utah Pollutant Discharge Elimination System (UPDES) - Obtain UPDES permit for storm water discharge from Utah Division of Water Quality (DWQ). Comply with the requirements of the permit including submittal of Notice of Intent (NOI) form to DWQ and development and approval of the storm water pollution prevention plan by the DWQ when required.
  7. Air Quality: Obtain construction approval from the Utah Division of Air Quality if construction project or area of disturbance outside of the project is in an area of air quality non-attainment for any pollutant.
- B. Contractor is responsible for all costs of pursuing and obtaining all the above clearances, and is not entitled to time extension for delays encountered in obtaining these clearances.

## **1.9 DISCOVERY OF HISTORICAL, ARCHEOLOGICAL, OR PALEONTOLOGICAL OBJECTS**

- A. Immediately suspend construction operations in the vicinity of the discovery if a suspected historic, archeological or paleontological item, feature, prehistoric dwelling sites or artifacts of historic or archeological significance are encountered.
- B. Verbally notify the Engineer of the nature and exact location of the findings.
- C. The Engineer contacts the State archeological authorities who will determine their disposition.
- D. Protect the discovered objects and provide written confirmation of the discovery to the Engineer within 2 calendar days.
- E. The Engineer keeps the Contractor informed concerning the status of the restriction.
  - 1. The time necessary for the Department to handle the discovered item, feature, or site is variable and dependent on the nature and condition of the discovered item.
  - 2. Expect a two (2) week or more delay in the vicinity of the discovery.
  - 3. The Engineer will provide written confirmation when the restriction is terminated.
- F. If a changed condition is approved, it will be controlled in accordance with Section 00725, article 1.4, Differing Site Conditions.

**PART 2 PRODUCTS Not used.**

**PART 3 EXECUTION Not used.**

END OF SECTION

**Change One – August 29, 2002**  
**No changes made**

**Change Two – December 19, 2002**  
**No changes made**

**Change Three – February 27, 2003**  
**Articles Revised**  
**1.3 A 3**

## **SECTION 01721**

### **SURVEY**

#### **PART 1      GENERAL**

##### **1.1      SECTION INCLUDES**

- A.      Schedule, coordinate, and provide all construction surveying, staking, calculations essential to complete the project and properly control the entire work.
- B.      Directed surveying as requested by the Engineer.

##### **1.2      RELATED SECTIONS**

- A.      Section 01282: Payment
- B.      Section 02896: Boundary Survey

##### **1.3      MEASUREMENT PROCEDURES**

- A.      Directed Survey: If extra survey work is needed, a 2-Person Crew measured by the hour authorized. Department makes no additional payment for travel time to and from the project.
- B.      Directed Survey: If extra survey work is needed a 3-Person Crew measured by the hour authorized. Department makes no additional payment for travel time to and from the project.

##### **1.4      PAYMENT PROCEDURES**

- A.      If needed and approved, directed survey work paid for in the accepted quantities at the following rates:

2 person survey crew	\$130.00 per hour
3 person survey crew	\$155.00 per hour
1 person computation and /or CAD	\$ 65.00 per hour

- B. The number of hours required for computations and/or drafting in total cannot exceed 33 percent of actual survey hours, established on a percent basis prior to directed survey work starts.

## **1.5 SUBMITTALS**

- A. The Department requires that a Professional Engineer or Professional Land Surveyor registered in the State of Utah sign and seal all submittals.
- B. Resubmittals may be required depending on completeness and correctness of the work.
- C. Prior to beginning work, submit a statement indicating all Department-provided horizontal and vertical control have been field checked and the control has been determined to be accurate within the tolerances specified in Article 3.4 "Control Point and Survey Tolerances." Attach field survey information used to verify control. If discrepancies are found, notify the Engineer verbally and in writing.
- D. Prior to beginning work, provide a written description of the equipment, manpower, methods, and data storage format proposed for use to complete all survey activities.
- E. Record keeping: Keep all field notes, diaries, and books according to standard surveying practice.
  - 1. Loose leaf books not acceptable.
  - 2. Make available at any time all survey records including field notebooks and forms used for the work to the Engineer upon verbal or written request.
  - 3. During construction, keep all documentation at a location approved by the Engineer.
- F. After project completion, return to the Engineer all surveying and design data and "as staked/constructed" drawings in Microstation format clearly showing all final dimensions, lines, grades, tie-ins and deviations from contract plans.
- G. Provide a red-lined hard copy plan set showing as-constructed features denoting changes from the original design.

## **1.6 QUALITY ASSURANCE**

- A. Responsible for survey and control of the work, and for correcting Contractor errors, whether the errors are discovered during the actual survey work or in subsequent phases of the project. Bear any cost overruns resulting from Contractor errors.

- B. Perform all work in accordance with the plans and specifications and standard Engineering and Surveying practices under the responsible charge of a Professional Engineer or Professional Land Surveyor duly and properly registered in Utah.
- C. The Engineer may spot check the work for accuracy and may reject unacceptable portions of work. Resurvey rejected work and correct work that is not within the specified tolerances at no additional expense to the Department.

## **PART 2 PRODUCTS**

### **2.1 EQUIPMENT**

- A. Furnish tools, supplies, and stakes suitable for use in highway survey work.
- B. Furnish stakes and hubs of sufficient length to provide a solid set in the ground with sufficient surface area above ground for necessary legible markings.
- C. Furnish survey instruments and supporting equipment capable of achieving the specified tolerances. Calibrate survey equipment for accuracy prior to beginning survey work and as required.

## **PART 3 EXECUTION**

### **3.1 PREPARATION**

- A. Discuss and coordinate the following with the Engineer before survey work begins:
  - 1. Required submittals
  - 2. Survey and staking methods
  - 3. Stake markings
  - 4. Grade control
  - 5. Referencing
  - 6. Structure control
  - 7. Any other procedures and control necessary for the work
  - 8. Documentation procedures
- B. Establish construction survey points, elevations and grades as necessary to control layout and complete the work. Verify all control surveying and staking meets specified tolerances for prior to beginning work.

- C. Calculate all grades, elevations, offsets and alignment data necessary for staking and/or setting items of work. Obtain approval from the Engineer for alternate methods of establishing grade control with wire lines, computer or laser controlled grading or other suitable methods.
- D. Provide appropriate traffic control for all survey activities.
- E. The Department furnishes:
  - 1. Plans showing locations of control points
  - 2. Plans showing locations of Bench Marks
  - 3. Cross sections developed during design, if any
  - 4. Electronic project data, if any
  - 5. Digital Terrain Model used for design, if any

### CONTRACT PROVISION DISCLAIMER

RELEASE OF UDOT DATA: Contractor may obtain an electronic copy of the Data Points prepared by UDOT. UDOT provides data points in Microstation and/or Inroads format only. Contractor responsible for translation into other formats. This data does not include the commercial software needed to read the points. In order to obtain an electronic copy, Contractor makes a written request to the Engineer. Contractor agrees and understands that the data points are prepared by UDOT for its own purposes and not for the benefit of private individuals or businesses. Contractor waives any and all claims that may result from the use of or reliance upon the data points. Contractor indemnifies UDOT and holds it harmless for any damages, costs, attorneys' fees, or other liabilities that might be incurred as a result of the Department's use and reliance on the data.

### 3.2 DIRECTED SURVEY

- A. Conduct directed surveying if requested by the Engineer.
  - 1. Includes work needed for changes and extra work. Provide all labor, materials, and equipment including global positioning satellite equipment.
  - 2. Obtain prior written authorization from the Engineer documenting the affected work and requirements before performing work under these items.

### 3.3 COMPUTATIONS AND PLOTS

- A. When work is modified by a change order, use cross-sections to calculate volume measurements.
  - 1. Superimpose final cross sections with original cross sections and calculate final quantities using the average end area method.

2. Develop cross-sections from field measurements.
  - a. Take cross section measurements both before and after excavation and prior to backfill.
  - b. When the centerline curve radius is less than or equal to 500 ft, take cross sections at a maximum centerline spacing of 25 ft.
  - c. When the centerline curve radius is greater than 500 ft, take cross sections at a maximum spacing of 50 ft.
  - d. Take additional cross sections at breaks in terrain and at changes in typical sections.
  - e. For each cross section, measure and record points at breaks in terrain, but at least every 25 ft unless otherwise approved by the Engineer.
  - f. Measure and record points to at least the anticipated slopes and reference locations.
  - g. Reduce all cross section distances to horizontal distances from centerline.
  - h. Take cross sections at right angles to tangents and normal to curves.
  - i. Include in cross sections all grades, locations, and existing ground line profiles.
3. May develop cross sections from digital terrain models provided that:
  - a. The ground survey locations do not exceed 100 ft in any direction
  - b. Major breaks in terrain are also included.
  - c. The horizontal and vertical control for the project is used
  - d. The DTM is verified accurate to require tolerances by spot checking throughout the length of the project.

B. Engineer may approve alternate methods of calculating quantities.

### **3.4 STAKE MAINTENANCE AND MARKING**

- A. Maintain ALL staking necessary for the work until the construction has been completed and accepted by the Engineer.
  1. Legibly mark all survey stakes with station and offset referenced to their respective control line.
  2. Mark slope, reference and guard stakes with station.
  3. Renew illegible stakes at no additional cost to the Department.
- B. Provide and maintain reference stakes that identify stationing at least every 150 ft until all work has been completed and accepted by the Engineer.

### 3.5 CONTROL POINT AND SURVEY TOLERANCES

- A. Relocate initial horizontal and vertical control points in conflict with construction to areas that will not be disturbed by construction operations. Furnish the coordinates and elevations for the relocated points before the initial points are disturbed.
- B. Protect bench marks from construction activities. Position all bench marks to allow a level rod to stand vertically and squarely on the mark. Reference bench marks to centerline and horizontal measurements.
- C. Survey and establish control within the following tolerances:

Description	Horizontal	Vertical
	Decimals of a foot	
Control points	" 0.01	" 0.01
Centerline points	" 0.04	" 0.04
Cross sections and slope stakes	" 0.10	" 0.10
Slope stake references	" 0.10	" 0.10
Culverts and Ditches	" 0.10	" 0.10
Minor drainage structures	" 0.10	" 0.04
Curb and gutter	" 0.02	" 0.02
Guardrail and concrete barrier	" 0.05	-----
Retaining walls	" 0.05	" 0.01
Bridge substructure and overall	" 0.01	" 0.01
Bridge superstructure and overall	" 0.01	" 0.01
Environmental Control Limits	" 1.00	-----
Clearing and grubbing limits	" 1.00	-----
Right of Way Limits	" 0.02	-----
Roadway subgrade finish stakes	" 0.10	" 0.10
Roadway finish grade stakes	" 0.04	" 0.04
Signals and electrical	" 0.08	" 0.04
Striping	" 0.08	-----
Paving reference line	" 0.04	" 0.01

Coordinate the survey tolerances of any items not listed above with the Engineer.

- D. Staking limits:
1. Stake clearing limits on both sides of centerline at each established station. Locate the clearing limit on the ground as shown by the cut and fill limits on the plans.
  2. Stake right of way limits every 50 ft maximum on tangents, every 25 ft maximum on curves and at all right of way breaks. If staking distance effects line of sight, reduce the distance.
  3. Stake environmental control limits both sides of centerline at each established station. Locate the environmental control limits on the ground as shown by the slope rounding contours and environmental and silt fence locations as shown on the Plans. Stake environmental control limits every 50 ft and every 25 ft where environmental or silt fence is required.
- E. Furnish reference stakes for all slope stakes and stakes used for setting items for work.
1. Maintain the reference stakes for the duration of the project until the Engineer approves removal.
  2. Establish and set slope stakes and references on both sides of centerline at cross section locations.
    - a. When the centerline curve radius is less than or equal to 500 ft, place slope stakes at a maximum centerline spacing of 25 ft.
    - b. When the centerline curve radius is greater than 500 ft, place slope stakes at a maximum spacing of 50 ft.
  3. Establish slope stakes in the field as the actual point of intersection of the design slope with the natural ground line.
  4. Set slope stake references outside the clearing limits.
  5. Include all reference point and slope stake information on the reference stakes.
- F. After the slope staking is completed, record on the cross section guard stakes the vertical distance from the reference point (RP) to the construction grade, at a minimum horizontal distance of 10 ft outside the clearing limits or at right of way.
- G. Setting grade finishing stakes:
1. For grade elevations and horizontal alignment:
    - a. On centerline.
    - b. On each shoulder at roadway cross section locations and between centerline and shoulder with a maximum spacing of 15 ft.
    - c. At the top of subgrade and the top of each aggregate course.
  2. Locations:
    - a. Where turnouts are constructed, set stakes on centerline, on each normal shoulder, and on the shoulder of the turnout.
    - b. In parking areas, set hubs at the center and along the edges of the parking area.
    - c. Set stakes in all ditches to be paved.

3. Maximum spacing between stakes along the alignment: 50 ft.
4. Use guard stakes, etc. at each grade finishing stake.
5. Reset grade finishing stakes as many times as necessary to construct the subgrade and each aggregate course.

### **3.6 CONCRETE PAVING**

- A. Develop a method of horizontal and vertical control for the placement of concrete pavement.
  1. Utilize laser, wire, or string line, for example, to maintain horizontal and vertical control.
  2. Maximum spacing: 50 ft.
  3. Set control on both sides of roadway.
- B. Profile surface at each edge of placement and adjust grades for smoothness as approved by the Engineer.
- C. Measure pavement thickness every 25 ft and adjust as needed.
- D. Stake concrete joint and station stamp locations.

### **3.7 DRAINAGE STRUCTURES**

- A. Stake drainage structures to fit field conditions and in coordination with the Engineer. The location of the structures may differ from the plans.
  1. Survey and record the ground profile along centerline of structure
  2. Determine the slope catch points at inlets and outlets.
  3. Set reference points and record information necessary to determine structure length and end treatments.
  4. Stake ditches or grade to make the structure functional.
  5. Plot the profile along centerline of the structure to show the natural ground, the flow line, the roadway section, and the structure.
  6. Mark guard stakes with the following, when applicable:
    - a. Diameter, length and type of culvert (for example 18 inch x 35 ft corrugated metal pipe (cmp))
    - b. The vertical and horizontal distance from the hub to the invert at the end of the culvert or any intermediate point as needed or directed
    - c. Flow line grade of the pipe
    - d. Station
  7. For storm sewers and waterlines provide a reference at a maximum spacing of 50 ft. Reference inverts of pipe at all manholes.

### **3.8 BRIDGES**

- A. Set a minimum of 3 horizontal and vertical control reference points to be used for surveying all bridge substructure and superstructure components, including but not limited to; pile locations and cutoffs, line and grade for abutments and bents, beam seats, anchor bolts and screed grades.
- B. Set intermediate slope stakes at bridge abutments to establish transitions. Place finish grade stakes on the centerline of abutment bearing and at the top of slope of all bridge berms. Place finish grade stakes on each side at top, mid-point or slope and toe of fill.

### **3.9 BOX CULVERTS**

- A. Set horizontal and vertical control and reference points. Establish and reference the centerline, back of parapet, skew, and flow line elevations at inlet, outlet and breaks.

### **3.10 CURB AND GUTTER**

- A. Set curb and gutter staking at 25 ft intervals on tangent and 10 ft intervals on curve radii. Set line and grade for curb and gutter within 0.02 ft. of the proposed or established grade line.

### **3.11 GUARDRAIL**

- A. Stake guardrail vertical and horizontal control at a maximum spacing of 25 ft on tangent sections and 10 ft on curved sections unless otherwise approved.

### **3.12 EXISTING SURVEY MONUMENTS**

- A. Under the direction of a surveyor licensed in the State of Utah, locate and reference all private and public land survey monuments that may be destroyed by project construction activities prior to disturbing those existing monuments.
- B. Complete referencing and reestablishing those existing monuments at no cost to the Department and before project completion.
- C. In some counties the county surveyor references and reestablishes the monuments.
  - 1. Notify the county surveyor at least 30 days prior to the destruction of any monument.

2. Coordinate the reestablishment of section corner and quarter corner monuments with the county surveyor.
  3. Submit drawings and notes showing references to section corners and quarter corners to the Engineer.
- D. If a monument is found during construction but is not shown on the contract plans and must be reset, the Department pays for the additional work under the Directed Survey item.

### **3.13 RETAINING WALLS**

- A. Set horizontal and vertical control and reference points. Establish and reference the centerline offsets for the walls, radius points, and the beginning and ending wall locations as shown on the plans.
- B. Set grade stakes as required for each lift of select material used on the MSE walls.
- C. Stake retaining wall vertical and horizontal control at a maximum spacing of 25 ft on tangent sections and 10 ft on curved sections unless otherwise approved.

### **3.14 CLEANUP**

- A. Remove and dispose of all flagging, lath, stakes and other staking material after the project is complete.

END OF SECTION

**Change One – August 29, 2002**

**No changes made**

**Change Two – December 19, 2002**

**No changes made**

**Change Three – February 27, 2003**

**Articles Revised**

**1.4 C deleted and moved to Measurement and Payment document**

## **SECTION 02222**

### **SITE DEMOLITION - CONCRETE**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Demolish, remove, and dispose of concrete pavement, curb, gutter, sidewalk, concrete driveway approach, waterway, and similar hard surfaces.

##### **1.2 RELATED SECTIONS**

- A. Section 00727: Control of Work.
- B. Section 02705: Pavement Sawing.

#### **PART 2 PRODUCTS Not used.**

#### **PART 3 EXECUTION**

##### **3.1 PREPARATION**

- A. Review all work procedures with Engineer.
- B. Coordinate utility location in accordance with Section 00727, article, "Cooperation With Utilities."
- C. Preserve all active utilities.
- D. Detours according to traffic control plan.

### **3.2 CONCRETE PAVEMENT REMOVAL**

- A. Saw cut existing pavement on the designated with straight vertical edges free from irregularities when joining new construction to existing pavement. Refer to Section 02705.
- B. Completely remove pavement down to the underlying base course or subgrade.

### **3.3 OBLITERATION**

- A. Break up concrete into pieces not over 1 ft<sup>2</sup> in area. Scarify and cover broken concrete with at least 1 ft of suitable backfill material.
- B. Fill depressions and blend with the surrounding contours.
- C. Grade materials either along the toe of an embankment or into a depression or borrow pit. Cover with at least 1 ft of suitable backfill material.

### **3.4 CONCRETE SIDEWALK, CONCRETE DRIVEWAY REMOVAL**

- A. Remove concrete to the nearest expansion joint or saw cut to provide proper grades and connections.
- B. Make concrete cuts straight, vertical to the surface, full depth, and free from irregularities. Refer to Section 02705.
- C. Thoroughly clean all adhering materials from existing reinforcement.
- D. Do not damage concrete designated to remain.

### **3.5 CONCRETE CURB, CONCRETE CURB AND GUTTER, RAISED ISLAND, BITUMINOUS CURB REMOVAL**

- A. Remove curb, curb and gutter, gutters, raised island, bituminous curb, and parts of such improvements to an existing joint or joint sawed with a vertical face.
- B. Remove material to provide proper grades and connections.

END OF SECTION

**Change One – August 29, 2002**

**No changes made**

**Change Two – December 19, 2002**

**No changes made**

**Change Three – February 27, 2003**

**Revised articles**

**Changed title from Site Demolition-Pavement to Site Demolition - Concrete**

**1.1 A**

**3.2 Title**

**3.2 A**

## **SECTION 02224**

# **DISPOSE OF ASPHALT PAVEMENT**

### **PART I      GENERAL**

#### **1.1      SECTION INCLUDES**

- A.      Dispose of all asphalt material properly.

#### **1.2      RELATED SECTIONS**

- A.      Section 01355: Environmental Protection
- B.      Section 02316: Roadway Excavation
- C.      Section 02330: Embankment

#### **1.3      PAYMENT PROCEDURES**

- A.      Include asphalt pavement removal in Roadway Excavation. Refer to Section 02316.

### **PART 2      PRODUCTS Not Used**

### **PART 3      EXECUTION**

#### **3.1      DISPOSAL**

- A.      On the Right-of-way
  - 1.      Use as embankment. Refer to Section 02330.

- B. Off the right-of-way: Refer to Section 01355.
  - 1. Acceptable when done according to prevailing laws (including environmental laws), ordinances, regulations, and rules.
  - 2. Furnish the Engineer with copies of the disposal permits or agreements.

END OF SECTION

**Change Three – February 27, 2003**  
**New Specification**

## **SECTION 02316**

# **ROADWAY EXCAVATION**

### **PART 1 GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Excavate all material within designated areas, including channels with a bottom width of 12.0 feet or greater. Widen cuts as directed.
- B. Rock excavation and removal.
- C. Dispose of excavated material; place in embankment and/or other areas.

#### **1.2 RELATED SECTIONS**

- A. Section 00725: Scope of Work
- B. Section 00820: Legal Relations and Responsibility to Public.
- C. Section 01571: Temporary Environmental Controls.
- D. Section 01721: Survey
- E. Section 02056: Common Fill.
- F. Section 02061: Select Aggregate.
- G. Section 02075: Geotextiles.
- H. Section 02231: Site Clearing and Grubbing.
- I. Section 02224: Dispose of Asphalt Pavement
- J. Section 02324: Compaction.
- K. Section 02912: Topsoil.

### **1.3 PAYMENT PROCEDURES**

- A. Pay for disposal of asphalt pavement under Section 02224.

### **1.4 REFERENCES**

- A. NEPA 495: Code for the Manufacture, Transportation, Storage, and Use of Explosive Materials.
- B. UOSH Construction Standards Chapter U: Blasting and the Use of Explosives.

### **1.5 DEFINITIONS**

- A. Rock: Solid mineral material that cannot be removed with equipment reasonably expected to be used in the work without cutting, drilling or blasting.

### **1.6 SUBMITTALS**

- A. Submit proposed method of blasting, delay pattern, explosive types, and type of blasting mat cover.

### **1.7 ACCEPTANCE**

- A. Grading Tolerance: Top surface of subgrade = " 0.1 foot of line and grade.
- B. Payment is plan quantity by the cubic yard. Make no adjustment to plan quantities if staked quantities differ from plan quantities by more than 5 percent +/-.
- C. Notify the Engineer in writing before beginning excavation in any area or balances of excavation if the Contractor determines that the staked quantities differ from the plan quantities by more than 5 percent +/- . The following procedures then apply:
  - 1. Provide calculations and plots in accordance with Section 01721, Article "Computations and Plots."
  - 2. Evaluate the "plan quantities" to "staked quantities" by individual cuts or balances as determined by the Engineer to provide the necessary accuracy.

3. Do not begin excavation of any cut sections that the Contractor determines to differ from plan quantities by more than 5 percent +/- until the calculations and plots have been submitted, reviewed, and approved quantities are determined with the Engineer. No payments, partial or final will be made until submissions are provided and approved.
- D. When the Engineer determines the staked quantities differ from plan quantities by more than 5 percent +/-, the approved quantities become the plan quantities (adjusted).
- E. When the Engineer directs changes in the alignment, grade, or scope of work that result in a change in the roadway excavation quantities, the revised quantities become the plan quantities (adjusted).
- F. Payment made at the original unit bid price for the plan quantities (adjusted).
- G. If plan quantities are adjusted from the original contract bid plan quantities, Section 00725, Article "Significant Changes in the Character of Work," applies.

## **1.8 STOCKPILING AND HANDLING**

- A. Stockpile excavated material at approved locations.
- B. Waste excess excavation as required.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS FOR OVER-EXCAVATED AREAS**

- A. Common Fill: Refer to Section 02056.
- B. Select Aggregate: Refer to Section 02061.
- C. Geotextile Fabric: Refer to Section 02075.

### **2.2 EXPLOSIVES**

- A. Type recommended by explosives firm.

## **2.3 DELAY FUSES**

- A. Type recommended by explosives firm.

## **2.4 BLASTING MATERIALS**

- A. Type recommended by explosives firm.

# **PART 3 EXECUTION**

## **3.1 PREPARATION AND PROTECTION**

- A. Refer to Section 01571.
- B. Pothole, expose, or otherwise locate buried utilities as necessary.
- C. Refer to Section 00820, article, "Protection and Restoration of Property and Landscape."
- D. Finish clearing and grubbing within the designated area following Section 02231 before starting excavation.

## **3.2 STORAGE OF BLASTING MATERIALS**

- A. Securely store all explosives in compliance with Laws and Regulations.
- B. Mark all storage places clearly.

## **3.3 TOPSOIL**

- A. Remove topsoil following Section 02912.

## **3.4 DEWATERING**

- A. Keep excavation free from surface and ground water through all stages of construction.
  - 1. Maintain adequate drainage during all stages of construction through pumping, pipe culverts and drainage ditches.

2. Provide temporary facilities when interrupting irrigation systems, sewer, underdrainage, etc.

### **3.5 EXCAVATION - STANDARD PROCEDURES**

- A. Finish excavation to reasonably smooth and uniform surface.
- B. Provide and maintain satisfactory access to roads, streets, and adjacent property during all phases of construction according to the Traffic Control Plan.
- C. Remove material in all cut section to the depth shown. When necessary to obtain compaction, scarify to an 8.0 inch depth and compact to at least 96 percent of maximum laboratory density. Refer to Section 02324.
- D. Excavate and waste unsuitable material.
- E. Material for backfilling or finishing.
  1. Use suitable granular material encountered in excavation to construct the top layers of embankment, for finishing the roadbed, or for backfill when directed by the Engineer.
  2. When practical, haul the granular material directly from excavation to the final position on the roadbed.
- F. Contractor-furnished borrow may be used and roadway excavation wasted if there is no additional cost to the Department. Provide borrow that is equal to or better quality than the wasted roadway excavation.

### **3.6 ROCK REMOVAL - NONEXPLOSIVE METHOD**

- A. Excavate solid rock 6.0 inches to 1.0 foot below subgrade and backfill with acceptable material.
  1. Rock removed more than 1.0 foot below subgrade will not be measured or paid for.
  2. Backfilling of depth greater than 1.0 foot below subgrade will not be measured or paid for.

### **3.7 ROCK REMOVAL- EXPLOSIVE METHOD**

- A. Comply with UOSH Constructions Standards Chapter U rules and regulations.
- B. Provide a qualified explosives expert to act as an advisor and consultant during drilling and blasting operations.

- C. Do not blast beyond designated areas.

### **3.8 ROCK FACES**

- A. Scale rock cuts of all loose rocks and fragments and leave in a neat and safe condition.

### **3.9 ASPHALT PAVEMENT**

- A. Saw cut existing asphalt pavement on the designated line with straight vertical edges free from irregularities when joining new construction to existing pavement. Refer to Section 02705.
- B. Excavate all asphalt pavement.

END OF SECTION

#### **Change One - August 29, 2002**

**No Changes made**

#### **Change Two – December 19, 2002**

**No Changes made**

#### **Change Three – February 27, 2003**

**Articles Revised**

**1.2 A, D, I added**

**1.3 added**

**1.7 B, C, D, E, F, G added**

**3.9 A added**

## **SECTION 02455**

# **DRIVEN PILES**

### **PART 1 GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Materials, equipment and procedures for driving steel piles.

#### **1.2 RELATED SECTIONS**

- A. Section 03055: Portland Cement Concrete.
- B. Section 03211: Reinforcing Steel and Welded Wire.

#### **1.3 REFERENCES**

- A. AASHTO M 31: Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- B. AASHTO M 183: Structural Steel.
- C. ASTM A 36: Carbon Structural Steel
- D. ASTM A 252: Welded and Seamless Steel Pipe Piles
- E. ANSI/AASHTO/AWS D 1.1

#### **1.4 SUBMITTALS**

- A. Complete and submit the “Pile and Driving Equipment Data” form located at the end of this Section.
  - 1. The Department uses this information to perform a pile driving wave equation analysis.
  - 2. Within 14 calendar days after submitting the form, the Engineer provides either:
    - a. Approval to continue
    - b. Notification of inadequate equipment.

3. Mobilize pile driver to the site only after the Engineer indicates that acceptable results of the wave equation analysis have been obtained.
4. Remove pile hammer and other related equipment found to be inadequate for the project pile driving conditions; and re-mobilize another hammer at no cost to the Department.
5. Provide accurate test information regarding the yield stress values for each batch (heat) of piles to be used on the project.

## **PART 2 PRODUCTS**

### **2.1 PIPE PILE SHELLS**

- A. Use new pipe pile shells having wall thickness as shown on plans.
- B. Meet requirements for ASTM A 252 steel, for either Grade 2 (normal strength) or Grade 3 (high strength) steel, or for other minimum yield stress value(s) shown on the plans.

### **2.2 “H” PILES**

- A. As specified on the plans.

### **2.3 PORTLAND CEMENT CONCRETE**

- A. Class A Concrete following Section 03055.

### **2.4 REINFORCING STEEL**

- A. Meet AASHTO M 31, Grade 60.
- B. Refer to Section 03211.

### **2.5 PILE DRIVER**

- A. Equip pile driver following manufacturer's recommendations.
- B. Leads:
  1. Used with all types of hammers.
  2. Free moving.
  3. Hold in the required position with guys, stiff braces, or both. Hold the pile parallel to the leads.

4. Accommodate the maximum length of the pile segment, and extend to the lowest point that the hammer must reach. Obtain approval from the Engineer before using followers.
- C. Driving Head: Fits the top of pile and provides full bearing.
- D. Hammer:
  1. With fully-operable adjustable settings.
  2. Rated energy as much or greater than the value indicated on the foundation plans.
  3. Install a new hammer cushion before beginning pile driving.
    - a. Inspect the hammer cushion with the Engineer present after completing 100 hours of pile driving.
    - b. Replace the cushion when it loses 25 percent or more of its original thickness.

## **PART 3 EXECUTION**

### **3.1 PREPARATION**

- A. Complete all foundation excavation before driving piles. Dewater excavation a minimum of 3 ft below bottom of footing at all times during pile driving.
- B. Compare designated position of piles with the locations of existing piles from previous construction, existing utilities, old foundations, and other potential conflicts. Notify the Engineer of any conflicts. The Engineer designates new pile locations as required to resolve conflicts with locations of existing piles or other conflicts.

### **3.2 DYNAMIC ANALYSIS**

- A. Notify the Engineer at least 2 working days before pile driving is to commence on the project, and at least 2 working days before piles are to be driven on all subsequent abutment, bent, or pier foundations.
- B. The Department performs dynamic testing using a Pile Driving Analyzer (PDA), during the driving of the initial pile at each abutment and bent location. Additional piles may be monitored by the Department if driving conditions warrant.

- C. Cooperate fully with the Department in the conducting of PDA including, but not limited to, the following:
  - 1. Provide adequate space and conditions for the PDA rig and equipment.
  - 2. Climb the driver leads as necessary to attach, check and remove PDA gauges; or provide a platform at least 4 feet square with a 4 feet high safety rail, equipped to be raised to the top of the pile located in the leads, to allow Department personnel to safely attach and remove the gauges.
  - 3. Begin installation of instrumentation after placing the pile in the leads. Allow approximately one hour per pile for installation of dynamic measuring equipment. Allow one additional hour for installation of measuring equipment after splicing, if splicing is performed.
  - 4. Reduce the energy of the hammer and/or make other adjustments as necessary, if the stress exceeds the specified limit.
  - 5. Drive piles to the required resistance as determined by the Department to obtain the specified ultimate loads, unless otherwise indicated by the Department.
  - 6. Where required by the Department, re-strike the PDA-tested pile after a sufficient time period (at least 24 hours or more after the initial driving of the pile). Do not perform re-strikes using a cold hammer. If a re-strike is to be performed after the hammer has not been used for over 2 hours, operate the hammer first on another pile for at least 200 blows before performing the PDA re-strike.
- D. The Department must approve the PDA results before pile driving proceeds for the remaining piles. The Department may revise the pile driving criteria during the dynamic test pile driving period, including re-establishing required pile tip elevations.
- E. Allow for the Department or PDA firm to conduct one analysis per foundation (abutment or bent), of the Case Pile Wave Analysis Program (CAPWAP) from the PDA testing. Suspend pile driving on the foundation until the CAPWAP results are presented and the Engineer gives notice that results indicate sufficient capacity has been obtained.

### **3.3 INSTALLATION**

- A. Pre-drill/pre-auger if the designated pile tip elevation cannot be reached by the approved pile driver. Do not drill holes greater in diameter than the diameter or other maximum dimension of the pile.
- B. Pile Splicing:
  - 1. Butt weld the entire pile cross section using full penetration welds as per ANSI/AASHTO/AWS D.1.1.

2. Use no more than one spliced section less than 6 ft, and splice no other section less than 30 ft for any pile.
  3. Inspect the driven pile section before splicing any pile section to determine if it has been distorted from its original shape, or otherwise damaged from pile driving operations. Remove the damaged portion where distortion/damage has occurred, before splicing the next segment.
- C. Keep driven piles within 6 inches of the designated position and keep exposed portion of the pile within 1/4 in/ft from vertical (or from direction otherwise shown for battered piles). Before proceeding with backfilling or other associated foundation work, verify that the criteria has been met at the ground surface at the end of pile driving. If either requirement is not met, contact the Engineer to determine the appropriate resolution. The Contractor bears all costs for any measures required to resolve the non-conformance.
- D. Drive additional piles at locations designated by the Engineer when replacing damaged piles and/or piles driven out of position and/or alignment as specified above.
- E. Drive down piles that were raised because of driving adjacent piles.
- F. Engineer evaluates the possible damage to piles from water collecting in open pipe piles. Drive additional piles as determined by the Engineer to resolve concerns with any such pile damage.
- G. Remove all loose, displaced, and foreign materials from around the completed piles leaving clean, solid surfaces to receive the concrete.
- H. Cutting and capping piles:
  1. Remove all damaged material from the top of the pile.
  2. Keep the sides of piles at least 9 inches away from the nearest edge of footing.
  3. Cut off piles with clean, straight-line cuts to the designated elevation at a right angle to the pile axis. Level all irregularities before placing concrete pile cap.
- I. Receive approval from Engineer prior to concrete placement.
- J. Embed the tops of piles in the concrete pile cap as shown on the plans.

### **3.4 CONCRETE FILLING OF PIPE PILES**

- A. Fill pipe piles with specified concrete shown on drawings, after compliance with all tolerances and required criteria have been established.

- B. Prior to filling pipe shell, fill any annular space between the pipe shell and the surrounding soil with grout or clean sand washed down to reestablish lateral support.
- C. Avoid segregation of the concrete ingredients.
- D. Slump at the time of placement: between 4 and 6 inches.
- E. Arrange chutes, pipes, etc. used as aids in placing concrete so concrete does not separate (i.e. flows freely without having to be pushed or shoveled).
- F. Place concrete in pipe shell either by free fall or through a tremie or concrete pump.
- G. Concrete placed by free-fall falls directly to the base without contacting either the rebar cage or the pipe wall. Use drop chutes or tremie as necessary to achieve this.
- H. Do not chute concrete directly into hole.
- I. If a hopper or concrete bucket is used, do not discharge concrete directly from the mixer into the hopper or bucket; discharge concrete into a funnel-type downpipe centered over the hopper or bucket.
- J. Use high frequency internal vibrators to densify concrete to at least 3 feet below the bottom of the rebar cage, or to at least 12 feet below the pile cutoff level, whichever is deeper.
- K. Do not allow vibrators to penetrate concrete that has taken initial set.
- L. If concrete placement is to occur after daylight hours, light the work site so all operations are plainly visible.

END OF SECTION

**Change One – August 29, 2002**

**No changes made**

**Change Two - December 19, 2002**

**Articles Revised**

**3.3 B 2**

**Change Three – February 27, 2003**

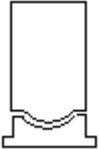

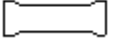


**Articles Revised**

**3.3 B 2 (corrected error from change two)**

A "Pile and Driving Equipment Data" form follows

## Pile and Driving Equipment Data

Project No: \_\_\_\_\_  
 Project Name: \_\_\_\_\_ County: \_\_\_\_\_  
 Drawing No: \_\_\_\_\_  
 General Contractor: \_\_\_\_\_  
 Pile Driving Contractor/Subcontractor: \_\_\_\_\_  
 Phone: \_\_\_\_\_ FAX: \_\_\_\_\_  
 (Piles driven by, foreman): \_\_\_\_\_  
 Date Submitted: \_\_\_\_\_

<b>Hammer Components</b>		<b>Hammer</b>	Manufacturer: _____ Model: _____ Type: _____ Serial No: _____ Manufacturer's Maximum Rated Energy: _____ (ft-lb) Stroke at Maximum Rated Energy: _____ (ft) Range in Operating Energy: _____ to _____ (ft-lb) Range in Operating Stroke: _____ to _____ (ft) Modifications: _____ _____																				
		<b>Ram</b>	Ram Weight: _____ (lb) Ram Length: _____ (ft) (for diesel hammers)																				
		<b>Anvil</b>	Ram Cross Sectional Area: _____ (in <sup>2</sup> ) (With diesel hammers) Anvil Weight: _____ (lb)																				
		<b>Hammer Cushion</b>	<table style="width: 100%; border: none;"> <tr> <th></th> <th style="text-align: center;">Material #1</th> <th style="text-align: center;">Material #2</th> </tr> <tr> <td>Name:</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>Area:</td> <td>_____</td> <td>_____ (in<sup>2</sup>)</td> </tr> <tr> <td>No. of Plates:</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>Thickness:</td> <td>_____</td> <td>_____ (in)</td> </tr> <tr> <td>Mod. of Elasticity - E:</td> <td>_____</td> <td>_____ (psi)</td> </tr> <tr> <td>Coeff. of Restitution - e:</td> <td>_____</td> <td>_____</td> </tr> </table>		Material #1	Material #2	Name:	_____	_____	Area:	_____	_____ (in <sup>2</sup> )	No. of Plates:	_____	_____	Thickness:	_____	_____ (in)	Mod. of Elasticity - E:	_____	_____ (psi)	Coeff. of Restitution - e:	_____
	Material #1	Material #2																					
Name:	_____	_____																					
Area:	_____	_____ (in <sup>2</sup> )																					
No. of Plates:	_____	_____																					
Thickness:	_____	_____ (in)																					
Mod. of Elasticity - E:	_____	_____ (psi)																					
Coeff. of Restitution - e:	_____	_____																					
	<b>Pile Cap</b>	Helmet Bonnet Anvil Block Weight: _____ (lb) Drive Head																					
<b>Pile</b>		<b>Pile Cushion (Only for Concrete or Timber Piles)</b>	Material: _____ Area: _____ (in <sup>2</sup> ) No. of Sheets: _____ Thickness/Sheet: _____ (in) Total Thickness of Pile Cushion: _____ (in) Mod. of Elasticity - E: _____ (psi) Coeff. of Restitution - e: _____																				
		<b>Pile</b>	Diameter: _____ (in) Wall Thickness: _____ (in) Taper (if any): _____ Length in Leads: _____ (ft) Ordered Length: _____ (ft) Required Ultimate Capacity: _____ (lb) Description of Splice: _____ Tip Treatment/Plate Description: _____																				

**Use Separate Data Sheet for Each Proposed Hammer and Unique Driving Condition**

## **SECTION 02721**

# **UNTREATED BASE COURSE (UTBC)**

## **PART 1 GENERAL**

### **1.1 SECTION INCLUDES**

- A. Production, construction, and compaction of untreated base course material.

### **1.2 RELATED SECTIONS**

- A. Section 01572: Dust Control and Watering

### **1.3 REFERENCES**

- A. AASHTO T 11: Materials Finer than 75  $\mu\text{m}$  (no. 200) Sieve in Mineral Aggregates by Washing.
- B. AASHTO T 19: Unit Weight and Voids in Aggregate.
- C. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates.
- D. ASHTO T 89: Determining the Liquid Limit of Soils.
- E. ASHTO T 90: Determining the Plastic Limit and Plasticity Index of Soils.
- F. AASHTO T 96: Resistance to Degradation of Small-Sized Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- G. AASHTO T 180: Moisture-Density Relations of Soils Using a 4.54 kg (10 lb) Rammer and 457 mm (18 in) Drop.
- H. AASHTO T 193: The California Bearing Ratio.
- I. AASHTO T 308: Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method.

- J. AASHTO T 310: Field Density and Moisture Content by Nuclear Gage.

#### 1.4 DEFINITIONS

- A. **Mean of the Deviations:** The sum of the absolute values of the deviations divided by the number of tests in the lot.

#### 1.5 SUBMITTALS

- A. Ten days before placement begins, submit a written report on the following:
1. Aggregate suitability. Refer to this Section, Part 2.
  2. Name of supplier and source.
  3. Job mix gradation including single values for each sieve size based on the dry weight of the aggregate.
- B. Resubmit all quality documents 24 hours before a day's production starts if a change in source is required.
1. Changes must fall within bands of Table 2 in this Section, and are subject to approval.
  2. Retroactive changes are allowed only for the first day's production for each construction season.

#### 1.6 QUALITY ASSURANCE

- A. Remove products found defective after installation and install acceptable products at no additional cost to the Department.

#### 1.7 ACCEPTANCE

- A. Engineer takes random sample from the grade.
- B. Acceptance will be on a lot-by-lot basis where a lot consists of a single layer of not more than 8000 yd<sup>2</sup> placed to line and grade and compacted. Divide the lot into five sublots of approximately 1600 yd<sup>2</sup> each. When working with small daily amounts, limit lot to maximum of two weeks worth of production and adjust subplot size accordingly.
1. Conduct one random moisture, gradation and density test within each subplot.  
AASHTO T 310.

- a. If the Mean of the Deviations of test results vary from the Combined Aggregate Target more than the minimum shown under the 0.70 pay factors of Table 2, the pay factor for the material allowed to remain in place is 0.50. This applies only if the Engineer does not order correction or removal of any or all of the material represented by the tests.
  - b. The results of five density tests must indicate that the average of 97 percent of maximum laboratory density has been met with no test less than 94 percent. AASHTO T 180, Method D.
- C. Do not place additional material on any unaccepted layer.
- D. Rework unacceptable material at no additional cost to the Department.
- E. Price Adjustments - Rap Content (AASHTO T-308)
1. Based upon average asphalt cement content per lot.
  2. Apply price adjustment to entire lot quantity.

**Table 1**

<b>Asphalt Cement Content over Design Content (% by Weight of Mix)</b>	<b>Price Adjustment (Dollars/ton)</b>
0.2 to 0.4	- 0.30
0.4 to 1.0	- 1.50
. 1.0	Reject*

\* Lots in Reject due to RAP content may stay in place, at the direction of the Engineer, with a 50% price adjustment.

<b>Table 2</b> <b>Pay Factors for Aggregate Gradation</b> <b>Mean of The Deviations of Sieve Gradation Results From The Combined Aggregate</b> <b>Target - Expressed in Percentage Points</b>						
<b>SIEVE SIZES</b>	<b>Pay Factor</b>	<b>1 TEST Max-min</b>	<b>2 TESTS Max-Min</b>	<b>3 TESTS Max-Min</b>	<b>4 TESTS Max-Min</b>	<b>5 TESTS or More Max - Min</b>
<b>½ inch and larger</b>	<b>1.00</b>	0 - 15	0.0 - 12.1	0.0 - 10.8	0.0 - 10.0	0.0 - 9.5
	<b>0.95</b>	16 - 17	12.2 - 13.9	10.9 - 12.4	10.1 - 11.5	9.6 - 11.0
	<b>0.90</b>	18 - 19	14.0 - 15.1	12.5 - 13.5	11.6 - 12.5	11.1 - 11.9
	<b>0.80</b>	20 - 21	15.2 - 17.2	13.6 - 15.3	12.6 - 14.2	12.0 - 13.5
	<b>0.70</b>	22 - 23	17.3 - 18.8	15.4 - 16.7	14.3 - 15.5	13.6 - 14.7
<b>3/8 inch</b>	<b>1.00</b>	0 - 15	0.0 - 11.5	0.0 - 9.8	0.0 - 8.8	0.0 - 8.0
	<b>0.95</b>	16 - 17	11.6 - 13.3	9.9 - 11.3	8.9 - 10.1	8.1 - 9.2
	<b>0.90</b>	18 - 19	13.3 - 14.4	11.4 - 12.3	10.2 - 11.0	9.3 - 10.0
	<b>0.80</b>	20 - 21	14.5 - 16.3	12.4 - 13.9	11.1 - 12.5	10.1 - 11.4
	<b>0.70</b>	22 - 23	16.4 - 17.9	14.0 - 15.2	12.6 - 13.6	11.5 - 12.4
<b>No. 4</b>	<b>1.00</b>	0 - 14	0.0 - 10.5	0.0 - 8.8	0.0 - 7.8	0.0 - 7.0
	<b>0.95</b>	15 - 17	10.6 - 12.1	8.9 - 10.1	7.9 - 9.0	7.1 - 8.0
	<b>0.90</b>	18	12.2 - 13.1	10.2 - 11.0	9.1 - 9.8	8.1 - 8.7
	<b>0.80</b>	19 - 20	13.2 - 14.9	11.1 - 12.5	9.9 - 11.1	8.8 - 10.0
	<b>0.70</b>	21 - 22	15.0 - 16.3	12.6 - 13.6	11.2 - 12.1	10.1 - 10.8
<b>No. 16</b>	<b>1.00</b>	0 - 11	0.0 - 8.2	0.0 - 6.9	0.0 - 6.2	0.0 - 5.6
	<b>0.95</b>	12 - 13	8.3 - 9.4	7.0 - 7.9	6.3 - 7.1	5.7 - 6.4
	<b>0.90</b>	14	9.5 - 10.3	8.0 - 8.6	7.2 - 7.8	6.5 - 7.0
	<b>0.80</b>	15 - 16	10.4 - 11.6	8.7 - 9.8	7.9 - 8.8	7.1 - 8.0
	<b>0.70</b>	17	11.7 - 12.7	9.9 - 10.7	11.7 - 12.7	8.1 - 8.7
<b>No. 50</b>	<b>1.00</b>	0 - 9	0.0 - 7.0	0.0 - 6.1	0.0 - 5.5	0.0 - 5.2
	<b>0.95</b>	10	7.1 - 9.0	6.2 - 7.0	5.6 - 6.3	5.3 - 6.0
	<b>0.90</b>	11	9.1 - 8.8	7.1 - 7.6	6.4 - 6.9	6.1 - 6.5
	<b>0.80</b>	12 - 13	8.9 - 10.0	7.7 - 8.7	7.0 - 7.8	6.6 - 7.4
	<b>0.70</b>	14	10.1 - 10.9	8.8 - 9.5	7.9 - 8.5	7.5 - 8.1
<b>No. 200</b>	<b>1.00</b>	0 - 4.5	0.0 - 3.4	0.0 - 2.9	0.0 - 2.5	0.0 - 2.3
	<b>0.95</b>	4.6 - 5.2	3.5 - 3.9	3.0 - 3.3	2.6 - 2.9	2.4 - 2.6
	<b>0.90</b>	5.3 - 5.6	4.0 - 4.3	3.4 - 3.6	3.0 - 3.1	2.7 - 2.9
	<b>0.80</b>	5.7 - 6.4	4.4 - 4.8	3.7 - 4.1	3.2 - 3.6	3.0 - 3.3
	<b>0.70</b>	6.5 - 7.0	4.9 - 5.3	4.2 - 4.5	3.7 - 3.9	3.5 - 3.6

F. Price Adjustments - Gradation:

1. Based upon number of samples per lot and the minimum pay factor.
2. Pay factors for aggregate gradation when tested in accordance with AASHTO T 27 are indicated in Table 2.

## PART 2 PRODUCTS

### 2.1 AGGREGATES

- A. Clean, hard, tough, durable and sound mineral aggregates that consist of crushed stone, crushed gravel or crushed slag; free of detrimental and organic matter; and complies with Table 3 and Table 4.

**Table 3**

<b>Aggregate Properties</b>		
Dry Rodded Unit Weight	Not less than 75 lb/ft <sup>3</sup>	AASHTO T 19
Material Passing No. 40 Sieve	Non plastic	AASHTO T 90/T 89
Aggregate Wear	Not to exceed 50 percent.	AASHTO T 96
Dry Weight Values	Within bands shown in Table 4	
Gradation Limits	Table 4	AASHTO T 11 AASHTO T 27
CBR with a 10 lb. surcharge	70% Minimum	AASHTO T 193

**Table 4**

<b>Gradation Limits – Single Value Job-Mix Formula</b>			
<b>Sieve Size</b>	<b>Percent Passing of Total Aggregate (Dry Weight)</b>		
	1-1/2 inch	1 inch	3/4 inch
1-1/2 inch	100	--	--
1 inch	--	100	--
3/4 inch	81 -91	--	100
1/2 inch	67 - 77	79 - 91	--
3/8 inch	--	--	78 - 92
No. 4	43 - 53	49 - 61	55 - 67
No. 16	23 - 29	27 - 35	28 - 38
No. 200	6 – 10	7 - 11	7 - 11

Untreated Base Course: Based on fine and coarse aggregate having approximately the same bulk specific gravities.

- B. Recycled Asphalt Pavement (RAP): When the Contractor elects to use RAP in the untreated base course, meet the following:

- a. Materials manufactured by rotomilling, crushing, or other means approved by the Engineer.
- b. Mechanically blend with the virgin material, resulting in a homogeneous material. Do not use windrows and graders/dozers for blending.
- c. Do not exceed target asphalt cement content, as calculated by total weight of mix, for final blend material (virgin and RAP).
- d. Meet all requirements of subsection 2.1, with the following modifications:
  1. L.A. Wear requirement applies to virgin aggregate portion only.
  2. Non-plastic requirement applies to virgin aggregate portion only.
  3. One fractured face and sand equivalent requirements apply to combined material residue from ignition oven.

## **PART 3      EXECUTION**

### **3.1      JOB-MIX GRADATION**

- A. Submit a written job-mix gradation for approval before production, including single values for each sieve size identified in Table 2, based on the dry mass of the aggregate.
- B. Meet Table 4 bands for dry mass values.
- C. For Blends using RAP:
  1. Limit target AC content to 2 percent by total weight of combined material.
  2. Submit two sets (five samples each) of ignition oven calibration samples containing blended material.
  3. Submit one set (five samples) of ignition oven calibration samples containing 100 percent virgin material.
  4. Modify drying procedures for gradation testing to minimize softening of the RAP asphalt cement. Reduce temperature and lengthen drying time. Recommended oven temperatures are approximately 140 degrees F with a drying time of 8 to 12 hours or until sample does not continue to lose mass.
- D. Procedures for Changing the Job-Mix Gradation
  1. Meet the requirements of Article 2.1 for all changes.
  2. Submit changes in writing 24 hours prior to start of production for approval by the Engineer.

### **3.2      INSTALLATION**

- A. Mixing: Provide an optimum moisture content of  $\pm 2$  percent at the time of placement. AASHTO T 180, Method D.
- B. Placing: Place layers in equal thickness and compact each layer to a thickness not to exceed 6 inches in depth. Do not place on a frozen subgrade or a frozen layer. Refer to Section 01572.
- C. Compaction: Meet requirements of Article 1.7 B-1. Maintain optimum moisture content  $\pm 2$  percent. AASHTO T 180, Method D and AASHTO T 310.
  - 1. Within 2 feet of back walls of structure abutments and approach slabs, use a hand-operated vibratory compactor or a vibratory roller.
  - 2. For blends using RAP where maximum laboratory density (AASHTO T 180, Method D) accurate field density values cannot be determined due to Asphalt Cement content, meet 98 percent of maximum field density, with no test less than 96 percent of maximum field density.
    - a. Maximum Field Density
      - i. Determined by use of a repetitive roller pattern over a two adjacent locations. Maximum Field Density is defined as the average of the maximum value attained on a nuclear density gauge for each location prior to breakdown of the material.
      - ii. Re-determine at least once per day.
- D. Finishing: Uniform line and grade with surface deviations no more than 3/8 inch  $\pm$  in 10 ft in any direction.
  - 1. Profile Tolerance — Correct any profile deficiency of greater than 3/8 inch.
    - a. Rework minimum of 4 inch lift to achieve homogeneous density
    - b. Determine limits of correction based on extent of deficiency. Extend work until existing deficiency is less than 3/8 inch.
- E. Quality Control Testing — Submit a quality control plan to the Engineer prior to construction. Perform tests as stated in the Quality Control plan.

#### END OF SECTION

#### **Change One – August 29, 2002**

##### **Revised Articles**

**1.2 D (added); H (replaced); I (deleted)**

**1.6 B 1**

**2.1 A Table 3**

**3.2 C**

#### **Change Two – December 19, 2002**

**No changes made**

**Change Three – February 27, 2003**

**Revised Articles**

**1.2 Related Sections added**

**1.3 H and I added**

**1.7 B**

**1.7 F deleted**

**2.1 B added**

**2.2 deleted**

**3.1 Title changed**

**3.2 B reference added**

**3.2 E added**

## **SECTION 02741**

### **HOT MIX ASPHALT (HMA)**

#### **PART 1 GENERAL**

##### **1.1 SECTION INCLUDES**

- A. Products and procedures for laying, and compacting a surface course of one or more layers of HMA comprised of aggregate, asphalt binder, lime and other additives.
- B. Mix materials at a central mixing plant.

##### **1.2 RELATED SECTIONS**

- A. Section 01452: Profilograph
- B. Section 02742S: Project Specific Surfacing Requirements
- C. Section 02745: Asphalt Material
- D. Section 02746: Hydrated Lime
- E. Section 02748: Prime Coat/Tack Coat
- F. Section 02969: Optional Use of Reclaimed Asphalt Pavement (PG Binder Projects Only)

##### **1.3 REFERENCES**

- A. AASHTO PP 28: Standard Practice for Superpave Volumetric Design for Hot-Mix Asphalt (HMA)
- B. AASHTO T 11: Materials Finer Than 75 Fm (No. 200) Sieve in Mineral Aggregates by Washing
- C. AASHTO T 19: Unit Weights and Voids in Aggregate
- D. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates

- E. AASHTO T 30: Mechanical Analysis of Extracted Aggregate
- F. AASHTO T 89: Determining the Liquid Limit of Soils
- G. AASHTO T 90: Determining the Plastic Limit and Plasticity Index of Soils
- H. AASHTO T 96: Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
- I. AASHTO T 104: Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
- J. AASHTO T 112: Clay Lumps and Friable Particles in Aggregate
- K. AASHTO T 166: Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated-Surface Dry Specimens
- L. AASHTO T 176: Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
- M. AASHTO T 195: Determining Degree of Particle Coating of Bituminous-Aggregate Mixtures
- N. AASHTO T 209: Maximum Specific Gravity of Bituminous Paving Mixtures
- O. AASHTO T 255: Total Moisture Content of Aggregate by Drying
- P. AASHTO T 283: Resistance of Compacted Bituminous Mixture to Moisture Induced Damage (Modified by UDOT Materials Manual of Instruction Part 8 Test Procedure 8-957)
- Q. AASHTO T 304: Uncompacted Void Content of Fine Aggregate
- R. AASHTO T 308: Determining the Asphalt Binder Content of Hot-Mix Asphalt (HMA) by the Ignition Method
- S. AASHTO T 312: Method for Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
- T. ASTM D 2950: Test Method for Density of Bituminous Concrete in Place by Nuclear Method
- U. ASTM D 3549: Thickness or Height of Compacted Bituminous Paving Mixture Specimens

- V. ASTM D 3665: Standard Practice for Random Sampling of Construction Materials
- W. ASTM D 3666: Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials
- X. ASTM D 4561: Practice for Quality Control Systems for Organizations Producing and Applying Bituminous Paving Materials
- Y. ASTM D 4791: Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
- Z. ASTM 5506: Practice for Organizations Engaged in the Certification of Personnel Testing and Inspecting Bituminous Paving Materials
- AA. ASTM D 5821: Determining the Percentage of Fractured Particles in Coarse Aggregate
- BB. ASTM E 178: Practice for Dealing with Outlying Observations
- CC. ASTM E 1274: Standard Test Method for Measuring Pavement Roughness Using a Profilograph
- DD. Asphalt Institute SP-1, SP-2
- EE. UDOT Materials Manual of Instruction Part 8-209: Asphalt Binder Management Plan
- FF. UDOT Materials Manual of Instruction Part 8-957: Resistance of Compacted Bituminous Mixture to Moisture Induced Damage
- GG. UDOT Materials Manual of Instruction Part 8-958: Standard Test Method for Determining Rutting Susceptibility
- HH. UDOT Materials Manual of Instruction Part 8-960: Guidelines for Superpave Volumetric Mix Design
- II. UDOT Materials Manual of Instruction Part 8-984: Sampling Methods

#### **1.4 ACCEPTANCE**

- A. A lot equals the number of tons of HMA placed during each production day. The Department will:
  - 1. Divide each lot into four sublots based on the scheduled production day.

2. Take random samples behind the paver before any further compaction, and determine random numbers/locations from a random numbers table. ASTM D 3665, UDOT Materials Manual of Instruction Part 8-984: Sampling Methods.
    - a. Take large enough samples for paired-T testing and split with contractor designated lab until testing discrepancies (based on tests outlined in article 3.9 "Dispute Resolution," paragraph B1, in addition to daily acceptance tests for mix properties) between labs are identified and resolved.
  3. Inform the Contractor of the time and place for the sample not more than 15 minutes prior to the sampling.
  4. Conduct the following tests:
    - a. Asphalt Binder Content: One per subplot using ignition oven. AASHTO T 308
    - b. Aggregate gradation: One test per subplot on the residue of the ignition oven tests. AASHTO T 30.
    - c. VMA: 3 tests per lot. AASHTO T 312
  5. Perform three Rice tests for each lot. Use the average for the lot to determine density of cores taken by the Contractor.
  6. Determine thickness of cores taken by the Contractor.
  7. Add the lot to the previous day's production if the minimum number of samples cannot be obtained for the final day's production and evaluate with the appropriate sample size.
  8. Add the lot to the next day's production if the minimum number of samples cannot be obtained, and evaluate with the appropriate sample size.
  9. Retest the lot if an individual test from a subplot is deemed an outlier based on ASTM E 178.
- B. The Engineer conducts the acceptance testing for asphalt binder content, gradation, VMA, density, and thickness. AASHTO T 30, T 308, PP 28, T 166, ASTM D 3549. For small projects with plan quantities of HMA less than 3000 tons or for work such as utility work, traffic signals, detours, lane leveling, etc., the Engineer may elect to accept material based upon visual inspection.
1. When acceptance is intended to be based upon visual inspection, the Engineer reserves the option of conducting any acceptance tests necessary to determine the material and workmanship meets the project requirements.
- C. Obtain samples for density and thickness.
1. Divide the lot into five sublots of approximately equal sizes.
  2. Obtain ten cores per lot randomly as instructed, and in the presence of the Engineer within two days after the pavement is placed.
  3. Comply with AASHTO T 166.

4. If the random location for cores falls within one foot of the edge of the overall pavement section (outer part of shoulders), then move transversely to a point one foot from the edge of the pavement.
  5. Fill core holes with an acceptable asphalt mixture and compact.
  6. The Department will take possession of the cores immediately, and will begin testing the cores within 24 hours for density acceptance.
    - a. Use Table 4 with  $n=10$  to determine PWL for density.
- D. Density: The target density for determining acceptance and incentive/disincentive is 93.5 percent of maximum Rice density for projects where design overlay thickness is greater than 2 inches. For projects where design overlay thickness is 2 inches or less, target density for determining acceptance and incentive/disincentive is 92.5 percent of maximum Rice density. AASHTO T 209. For small projects with plan quantities of HMA less than 3000 tons or for work such as utility work, traffic signals, detours, or lane leveling and when material is to be accepted on the basis of visual inspection per article 1.4 "Acceptance," paragraph B, acceptance for density may be based upon establishing and maintaining a roller pattern to obtain maximum density without over-stressing the pavement.
1. Obtain a minimum of two density determinations on a random basis for each subplot. ASTM D 3665.
  2. When samples for gradation, asphalt binder content and VMA from lots are combined according to Part 3, article 3.9 "Dispute Resolution," in order to obtain an appropriate sample size for evaluation, a lot for density determination is defined as the combined production days.
- E. Thickness: Base acceptance on the average thickness of a lot. A thickness lot equals a density lot. Divide a thickness lot into five sublots equal to density sublots. Thickness acceptance for thin lift projects (2 inches or less) consists of checking thickness regularly with a depth probe during placement and taking corrective action as necessary.
1. Take a minimum of two randomly selected thickness tests within each subplot.
  2. The same core samples taken for density may be used for thickness verification.
  3. The Department accepts a lot when:
    - a. The average thickness of all sublots is not more than 1/2 inch greater nor 1/4 inch less than the total thickness specified.
    - b. No individual subplot shows a deficient thickness of more than 3/8 inch.
    - c. Place additional materials where lots or sublots are deficient in thickness. The minimum depth of compacted surface for correcting deficient thickness is 3 times the nominal maximum aggregate size.
    - d. The Department pays for the quantity of additional material to bring the surface to design grade.

- e. The Department does not pay for the quantity of additional material above the design grade due to the minimum paving thickness required.
  - f. The Engineer may allow excess thickness to remain in place or may order its removal. Remove and replace the entire depth of the course, if it is necessary to remove portions of the course.
  - g. The Department pays for 50 percent of the mix in excess of the +1/2 inch tolerance when excess thickness is allowed to remain in place.
  - h. The thickness tolerances established above do not apply to leveling courses. However, check final surfaces in stage construction.
- F. Smoothness Tests
  - 1. Determine acceptance and correct in accordance with Section 01452.
- G. Cease production when any two out of three consecutive lots have a net disincentive or the air voids averaged for each lot are not between 3 and 5 percent for any 2 out of 3 consecutive lots.
  - 1. Before production continues, submit a corrective action plan to the Engineer indicating the changes in production procedures that will be implemented to correct the deficiencies.
- H. The Department pays incentive/disincentive on the assessed quantities of HMA mix according to Table 1 Incentive/Disincentive for Gradation, Asphalt Binder Content and Density or Table 2 Incentive/Disincentive for VMA. Base the incentive/disincentive on Percent Within Limit (PT) computation using Tables 3, 4, and 5. Use lowest single value combined for gradation (each of the sieves) and asphalt binder content for calculating the gradation/asphalt binder content incentive/disincentive in Table 1.
  - 1. Meet PT of 88 or greater for density for eligibility for incentive in gradation/asphalt binder content and VMA. The Department does not pay incentive for gradation/asphalt binder content and VMA if the Contractor does not meet this condition.
  - 2. For small projects with plan quantities of HMA less than 3000 tons, or for work such as utility work, traffic signals, detours, or lane leveling and when material is accepted on the basis of visual inspection per article 1.4 "Acceptance," paragraph B, incentives/disincentives do not apply.
- I. The Department rejects the lot if the Percent Within Limits (PT) for any individual measurement is less than 60 percent.
- J. To reduce over-testing of small quantity production days such as ramps or bridgework, the Engineer may, in concurrence with the Contractor, choose to combine production from several days to form a single lot.

<b>Table 1</b> <b>Incentive/Disincentive for Gradation, Asphalt Binder Content and Density</b>			
<b>Gradation/Asphalt Binder Content</b>		<b>Density</b>	
<b>PT Based on Min. Four Samples</b>	<b>Incentive/Disincentive (Dollars/Ton)</b>	<b>PT Based on Min. Ten Samples</b>	<b>Incentive/Disincentive (Dollars/Ton)</b>
> 99	0.83	> 99	0.83
96-99	0.67	96-99	0.67
92-95	0.37	92-95	0.37
88-91	0.06	88-91	0.06
84-87	-0.24	84-87	-0.24
80-83	-0.54	80-83	-0.54
76-79	-0.84	76-79	-0.84
72-75	-1.15	72-75	-1.15
68-71	-1.45	68-71	-1.45
64-67	-1.75	64-67	-1.75
60-63	-2.06	60-63	-2.06
<60	Reject	<60	Reject

<b>Table 2</b> <b>Incentive/Disincentive for VMA</b>	
<b>PT Based on Minimum Three Samples</b>	<b>Incentive/Disincentive (Dollars/Ton)</b>
> 99	0.49
96-99	0.39
92-95	0.18
88-91	-0.03
84-87	-0.24
80-83	-0.44
76-79	-0.64
72-75	-0.85
68-71	-1.06
64-67	-1.27
60-63	-1.47
<60	Reject

<b>Table 3</b> <b>Upper and Lower Limit Determination</b>	
<b>Parameter</b>	<b>UL and LL</b>
3/4 inch sieve for 1 inch HMA 1/2 inch sieve for 3/4 inch HMA 3/8 inch sieve for 1/2 inch HMA No. 4 sieve for 3/8 inch HMA	Target Value " 6.0%
No. 8 sieve	Target Value " 5.0%
No.50 sieve	Target Value " 3.0%
No. 200 sieve	Target Value " 2.0%
Asphalt Binder Content	Target Value " 0.35%
VMA Production Range	Field Target Value $\pm$ 1.25%
Target Range (Field)	12.5 % - 13.5 % for 1 inch 13.5 % - 14.5 % for 3/4 inch 14.5 % - 15.5 % for 1/2 inch 15.5 % - 16.5 % for 3/8 inch
Target Range (Design)	Modified as necessary to meet field target range
Density	Lower Limit: Target Value - 2.0% Upper Limit: Target Value + 3.0%

<b>Table 4 Quality Index Values for Estimating Percent Within Limits</b>										
<b>PU/PL</b>	<b>n=3</b>	<b>n=4</b>	<b>n=5</b>	<b>n=6</b>	<b>n=7</b>	<b>n=8</b>	<b>n=10</b>	<b>n=12</b>	<b>n=15</b>	<b>n=20</b>
100	1.16	1.50	1.75	1.91	2.06	2.15	2.29	2.35	2.47	2.56
99	1.16	1.47	1.68	1.79	1.89	1.95	2.04	2.09	2.14	2.19
98	1.15	1.44	1.61	1.70	1.77	1.80	1.86	1.89	1.93	1.97
97	1.15	1.41	1.55	1.62	1.67	1.69	1.74	1.77	1.80	1.82
96	1.15	1.38	1.49	1.55	1.59	1.61	1.64	1.66	1.69	1.70
95	1.14	1.35	1.45	1.49	1.52	1.54	1.56	1.57	1.59	1.61
94	1.13	1.32	1.40	1.44	1.46	1.47	1.49	1.50	1.51	1.53
93	1.12	1.29	1.36	1.38	1.40	1.41	1.43	1.43	1.44	1.46
92	1.11	1.26	1.31	1.33	1.35	1.36	1.37	1.37	1.38	1.39
91	1.10	1.23	1.27	1.29	1.30	1.31	1.32	1.32	1.32	1.33
90	1.09	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.27	1.27
89	1.08	1.17	1.20	1.21	1.21	1.21	1.21	1.21	1.22	1.22
88	1.07	1.14	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17
87	1.06	1.11	1.12	1.12	1.12	1.13	1.13	1.13	1.13	1.13
86	1.05	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04
84	1.02	1.02	1.02	1.01	1.01	1.01	1.00	1.00	1.00	1.00
83	1.00	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96
82	0.98	0.96	0.95	0.94	0.94	0.93	0.93	0.92	0.92	0.92
81	0.96	0.93	0.92	0.91	0.90	0.90	0.89	0.89	0.89	0.88
80	0.94	0.90	0.88	0.87	0.86	0.86	0.85	0.85	0.85	0.85
79	0.92	0.87	0.85	0.84	0.83	0.83	0.82	0.82	0.82	0.81
78	0.89	0.84	0.82	0.81	0.80	0.79	0.79	0.78	0.78	0.78
77	0.87	0.81	0.79	0.78	0.77	0.76	0.76	0.75	0.75	0.75
76	0.84	0.78	0.76	0.75	0.74	0.73	0.72	0.72	0.72	0.72
75	0.82	0.75	0.73	0.72	0.71	0.70	0.69	0.69	0.69	0.68
74	0.79	0.72	0.70	0.68	0.67	0.67	0.66	0.66	0.66	0.65
73	0.77	0.69	0.67	0.65	0.64	0.64	0.62	0.62	0.62	0.62
72	0.74	0.66	0.64	0.62	0.61	0.61	0.60	0.59	0.59	0.59
71	0.71	0.63	0.60	0.59	0.58	0.58	0.57	0.56	0.56	0.56
70	0.68	0.60	0.58	0.56	0.55	0.55	0.54	0.54	0.54	0.53
69	0.65	0.57	0.55	0.54	0.53	0.52	0.51	0.51	0.51	0.50
68	0.62	0.54	0.52	0.51	0.50	0.50	0.48	0.48	0.48	0.48
67	0.59	0.51	0.49	0.48	0.47	0.47	0.46	0.45	0.45	0.45
66	0.56	0.48	0.46	0.45	0.44	0.44	0.43	0.42	0.42	0.42
65	0.53	0.45	0.43	0.42	0.41	0.41	0.40	0.40	0.40	0.39
64	0.49	0.42	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.37
63	0.46	0.39	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34
62	0.43	0.36	0.34	0.33	0.33	0.33	0.32	0.31	0.31	0.31
61	0.39	0.33	0.31	0.30	0.30	0.30	0.29	0.29	0.29	0.28
60	0.36	0.30	0.28	0.27	0.26	0.26	0.25	0.25	0.25	0.25
<60	#0.35	#0.29	#0.27	#0.26	#0.25	#0.25	#0.24	#0.24	#0.24	#0.24

Enter table in the appropriate sample size column and round down to the nearest value.

**Table 5**

<b>Definitions, Abbreviations, and Formulas for Acceptance</b>	
<b>Term</b>	<b>Explanation</b>
Target Value (TV)	The target values for gradation, asphalt binder content and VMA are given in the Contractor's volumetric mix design. See article 1.4, D., line E, for density target values.
Average (AVE)	The sum of the lot's test results for a measured characteristic divided by the number of test results; the arithmetic mean.
Standard Deviation (s)	The square root of the value formed by summing the squared difference between the individual test results of a measured characteristic and AVE, divided by the number of test results minus one. This statement does not limit the methods of calculations of s; other methods that obtain the same value may be used.
Upper Limit (UL)	The value above the TV of each measured characteristic that defines the upper limit of acceptable production. (Table 3)
Lower Limit (LL)	The value below the TV of each measured characteristic that defines the lower limit of acceptable production (Table 3)
Upper Quality Index (QU)	$QU = (UL - AVE)/s$
Lower Quality Index (QL)	$QL = (AVE - LL)/s$
Percentage of Lot Within UL (PU)	Determined by entering Table 4 with QU.
Percentage of Lot Within LL (PL)	Determined by entering Table 4 with QL.
Total Percentage of Lot (PL) Within UL and LL (PT)	$PT = (PU + PL) - 100$
Incentive/Disincentive	Determined by entering Table 1 and 2 with PT or PL.

All values for AVE, s, QU, and QL will be calculated to two decimal place accuracy, which will be carried through all further calculations. Rounding to lower accuracy is not allowed.

## **PART 2      PRODUCTS**

### **2.1      ASPHALT BINDER**

- A.      Refer to Special Provision 02742S: Project Specific Surfacing Requirements.
- B.      Asphalt material: Refer to Section 02745.
- C.      Sampling procedure: UDOT Materials Manual of Instruction Part 8-209
- D.      Asphalt Binder Management Plan: UDOT Materials Manual of Instruction Part 8-209

### **2.2      AGGREGATE**

- A.      Refer to the Minimum Test Requirements.
- B.      Crusher processed virgin aggregate material consisting of crushed stone, gravel, or slag. Conform to Section 02969 for recycled mixes.
- C.      Use the following requirements, including Table 6, to determine the suitability of the aggregate.
  - 1.      Coarse aggregates:
    - a.      Retained on No. 4 sieve.
  - 2.      Fine aggregates:
    - a.      Clean, hard grained, and angular.
    - b.      Passing the No. 4 sieve.

**Table 6**

<b>Aggregate Properties - HMA</b>			
<b>Test Method</b>	<b>Test No.</b>	<b>Category 1</b>	<b>Category 2</b>
One Fractured Face	ASTM D 5821	95% min.	85% min. (1 inch and 3/4 inch), and 90% min. (1/2 inch and 3/8 inch)
Two Fractured Face	ASTM D 5821	90% min.	80% min. (1 inch and 3/4 inch), and 90% min. (1/2 inch and 3/8 inch)
Fine Aggregate Angularity	AASHTO T 304	45 min.	45 min.
Flat and Elongated 1 to 3 ratio	ASTM D 4791 (Based on 3/8 inch sieve and above)	20% max.	20% max.
L.A. Wear	AASHTO T 96	35% max.	40% max.
Sand Equivalent	AASHTO T 176 (Pre-wet method)	60 min.	45 min.
Plasticity Index	AASHTO T 89 and T 90	0	0
Unit Weight	AASHTO T 19	min. 75 lb/cu. ft.	min. 75 lb/cu. ft.
Soundness (sodium sulfate)	AASHTO T 104	16 % max. loss with five cycles	16 % max. loss with five cycles
Clay Lumps and Friable Particles	AASHTO T 112	2% max	2% max.
Natural Fines	N/A	0%	10% max.
Category 1: National Highway System and Truck Routes - Table 11. Category 2: All Other Routes			

- D. Meet gradation requirements in Table 7.

**Table 7**

<b>Aggregate Gradations (Percent Passing by Dry Weight of Aggregate)</b>					
<b>Sieve Size</b>		<b>1 inch (SHRP 25 mm)</b>	<b>3/4 inch (SHRP 19 mm)</b>	<b>1/2 inch (SHRP 12.5 mm)</b>	<b>3/8 inch (SHRP 9.5 mm)</b>
<b>Control Sieves</b>	<b>1-1/2 inch</b>	100.0	-	-	-
	<b>1 inch</b>	90.0 - 100.0	100.0	-	-
	<b>3/4 inch</b>	<90	90.0 - 100.0	100.0	-
	<b>1/2 inch</b>	-	<90	90.0 - 100.0	100.0
	<b>3/8 inch</b>	-	-	<90	90.0 - 100.0
	<b>No. 4</b>	-	-	-	< 90
	<b>No. 8</b>	19.0 - 45.0	23.0 - 49.0	28.0 - 58.0	32.0 - 67.0
	<b>No. 200</b>	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0

## 2.3 HYDRATED LIME

- A. Meet the requirements of Section 02746.

## 2.4 VOLUMETRIC DESIGN

- A. Comply with all requirements for Superpave Volumetric Mix Design according to Asphalt Institute, SP-1, and SP-2, AASHTO PP 28 and the following:
1. Meet the requirements of Table 8 and Table 9.
  2. Use a laboratory qualified by UDOT Central Materials in the use of the Superpave Gyratory Compactor. AASHTO T 312.
  3. Use an FHWA-protocol approved Superpave Gyratory Compactor.
  4. Meet all volumetric mix design requirements for the selected target gradation.
- B. Submit the Volumetric Mix Design data for verification at least 10 working days before beginning paving. Do not begin paving until verification is complete.
1. Include all information regarding selection of design aggregate structure showing the target values of percent passing on all sieves listed in Table 7, and the design asphalt binder content.

2. Provide information that aggregate proposed for use meet the requirements of Table 6.
  3. Supply QC data for target job mix gradation selection. Use those target values for price adjustments.
  4. After the design is complete, run 4 sets of 2 Gyratory specimens at the design asphalt binder content to verify the optimum asphalt and all other design requirements.
- C. Moisture Susceptibility
1. Incorporate hydrated lime into all volumetric designs. Use 1 percent, minimum, for Method A and 1½ percent, minimum for Method B (Section 02746 – Hydrated Lime).
- D. Designate asphalt binder supplier.
- E. Use gyratory mixing and compaction temperatures supplied by the Engineer.
- F. The Department Region Materials Lab verifies the Volumetric Mix Design. UDOT Materials Manual of Instruction Part 8-960: Guidelines for Superpave Volumetric Mix Design. For small projects with plan quantities of HMA less than 3000 tons, or for work such as utility work, traffic signals, detours, or lane leveling, the Region Materials Engineer may accept the Volumetric Mix Design from data submitted with the proposed mix design or from a previous mix design. The Region Materials Engineer reserves the right to verify any mix design submitted.
- G. Comply with the following requirements for Superpave volumetric mix design:

**Table 8**

<b>Volumetric Design Gyration</b>				
<b>20 Years Design ESALS (Million)</b>	<b>Compaction Parameters</b>			<b>Voids Filled with Asphalt (VFA) (%)</b>
	<b>N<sub>initial</sub> /% of G<sub>mm</sub> *</b>	<b>N<sub>design</sub> /% of G<sub>mm</sub> *</b>	<b>N<sub>max</sub> /% of G<sub>mm</sub> *</b>	
0.3	6/# 91.5	50/ ≥ 96.5	75/ # 98	70 - 80 **
0.3 to <3	7/# 90.5	75/ ≥ 96.5	115/ # 98	65 - 78
3 to < 30	8/# 89	100/ ≥ 96.5	160/ # 98	65 - 75
\$30	9/ # 89	125/ ≥ 96.5	205/ # 98	65 - 75

\* G<sub>mm</sub>: Maximum specific gravity of Mix. (Rice Method)

\*\* 67 percent specified lower limit VFA for 1 inch nominal maximum size mixture.

**Table 9**

<b>Volumetric Design Requirements</b>	
HMA design mixing and compaction temperatures	Provided by the Engineer
Dust Proportion Range	0.6 - 1.40
Voids in Mineral Aggregate (VMA) at $N_{\text{design}}$ AASHTO PP 28.9.2, using $G_{\text{sb}}$ at SSD. Equation based on percent of total mix.	Sufficient to Achieve Field Performance (Submit calculations or documentation to substantiate)
Hamburg Wheel Tracker UDOT Materials Manual of Instruction Part 8-990	Maximum 10 mm impression at 20,000 cycles.

- H. Prepare and submit 2 sets (5 samples each) of ignition oven calibration samples.
1. Department uses these samples to determine the correction factors for the Region and Field lab ignition oven.
  2. Submit samples a minimum of three working days prior to paving.

## **2.5 CONTRACTOR INITIATED CHANGES IN MIX DESIGN**

- A. Submit all requests in writing at least 12 hours prior to incorporating changes into production.
- B. Submit a field volumetric mix design for all target changes.
1. Field volumetric mix design verification consists of 3 sets of 2 gyratory specimens run at the new target gradation and/or asphalt binder content. The Department's previous acceptance tests are allowed for field verification.
  2. If the field volumetric mix design meets the volumetric requirements, the Engineer, in consultation with the Region Materials Engineer, provides written concurrence of the verified field volumetric mix design.
  3. If the field volumetric mix verification does not meet the volumetric requirements, submit a new laboratory volumetric mix design from a laboratory qualified by UDOT Central Materials. Allow at least 4 working days for verification.
  4. The Department performs up to two volumetric mix design verifications at no cost to the Contractor. The Department charges \$3000 for each additional laboratory and/or field verification required, including all laboratory or field volumetric mix design verifications required due to contractor initiated target changes.

- C. Submit a new laboratory volumetric mix design if changes occur in the aggregate source, asphalt binder source or grade.
- D. Do not make changes to production mix until request is reviewed and verified.

## **PART 3      EXECUTION**

### **3.1      ADDING HYDRATED LIME**

- A.      Method A, Lime Slurry; or Method B, Lime Slurry Marination: Refer to Section 02746.

### **3.2      HMA**

- A.      Dry aggregate to an average moisture content of not more than 0.2 percent by weight. AASHTO T 255. Adjust burners to avoid damage or soot contamination of the aggregate.
- B.      Coat with asphalt binder 100 percent of the particles passing and 98 percent of the particles retained on the No. 4 sieve.
  - 1.      AASHTO T 195.
  - 2.      Discontinue operation and make necessary corrections if material is not properly coated.
- C.      Maintain temperature of the HMA between established limits.
  - 1.      Do not overheat the material or cause thermal damage to the asphalt binder.
  - 2.      Department rejects and Contractor removes materials heated over the established limits.
  - 3.      Remove all material rejected by the Department for overheating.

### **3.3      HMA PLANT**

- A.      Provide:
  - 1.      Positive means to determine the moisture content of aggregate.
  - 2.      Positive means to sample all material components.
  - 3.      Sensors to measure the temperature of the HMA at discharge.
  - 4.      The ability to maintain discharge temperature of the mix in accordance with the mix design.
- B.      Asphalt Binder Storage Tanks:
  - 1.      Provide calibrated tanks so the quantity of material remaining in the tank can be determined at any time.

2. Provide a positive means of sampling the asphalt binder from the tanks.

### **3.4 SURFACE PREPARATION**

- A. Locate, reference, and protect all utility covers, monuments, curb and gutter, and other components affected by the paving operations.
- B. Remove all moisture, dirt, sand, leaves, and other objectionable material from the prepared surface before placing the mix.
- C. Complete spot leveling 48 hours before placing pavement courses.
  1. Place, spread, and compact leveling mix on portions of the existing surface.
  2. Fill and compact any localized potholes more than 1 inch deep.
- D. Allow sufficient cure time for prime coat/tack coat prior to placing HMA. Refer to Section 02748.

### **3.5 SURFACE PLACEMENT**

- A. When full-width or echelon paving is impractical and more than one pass is required, provide a 3:1 (horizontal to vertical) sloped edge adjacent to the next lane to be paved.
- B. Adjust the production of the mixing plant and material delivery until a steady paver speed is maintained.
- C. Offset longitudinal joints 6 to 12 inches in succeeding courses.
  1. Place top course joint within one foot of the centerline or lane line.
  2. If the previous pass has cooled below 175EF, tack the longitudinal edge before placing the adjacent pass.
- D. Offset transverse construction joints at least 6 ft longitudinally to avoid a vertical joint through more than one course.
- E. Do not allow construction vehicles, general traffic, or rollers to pass over the uncompacted end or edge of freshly placed mix until the mat temperature drops to a point where damage or differential compaction will not occur.
- F. Taper the end of a course subjected to traffic at approximately 50:1 (horizontal to vertical).
  1. Make a transverse joint by saw or wheel cutting and removing the portion of the pass that contains the tapered end.

2. Tack the contact surfaces before fresh mix is placed against the compacted mix.
- G. Use a motor grader, spreader box, or other approved spreading methods for projects under 180 yd<sup>2</sup>, irregular areas, or for miscellaneous construction such as detours, sidewalks, and leveling courses.

### **3.6 COMPACTION**

- A. Use a small compactor or vibratory roller in addition to normal rolling at structures.
- B. Operate in a transverse direction next to the back wall and approach slab.

### **3.7 LIMITATIONS**

- A. Do not place HMA on frozen base or subbase.
- B. Use a UDOT approved release agent for all equipment and hand tools used to mix, haul, and place the HMA. Refer to UDOT's Accepted Products Listing (APL) and the Performance Data Products Listing (PDPL).
- C. Do not place HMA during adverse climatic conditions, such as precipitation, or when roadway surface is icy or wet.
- D. Place HMA from April 15, and October 15, and when the air temperature in the shade and the roadway surface temperature are above 50 degrees F.
  1. The Department determines if it is feasible to place HMA outside the above limits. Obtain written approval from the Engineer prior to paving from October 15, to April 15.

### **3.8 CONTRACTOR QUALITY CONTROL**

**This Section does not apply to projects of 20,000 tons or less.**

- A. General
  1. Reference the following standards for qualification, control, and guidelines:
    - a. ASTM D 3666
    - b. ASTM D 4561
    - c. ASTM D 5506
  2. Include the following tests in ASTM D 5506, Part 2, "Referenced Documents," for the following:
    - a. AASHTO T 308
    - b. AASHTO T 312, PP 28

- c. AASHTO T 283 Modified by UDOT Materials Manual of Instruction Part 8-957
  - d. ASTM E 1274
- 3. Establish and maintain a quality control system providing assurance that materials and completed construction conform to Contract requirements.
- 4. Identify the Quality Control Manager by name. The Quality Control Manager implements and maintains the Quality Control Plan.
- 5. Provide the Engineer a certification stating that all the testing equipment to be used is properly calibrated and meets the specifications applicable for the specified test procedures. Provide evidence that Technicians are WAQTC certified. The Engineer may require the Contractor's technician to perform testing of samples to demonstrate an acceptable level of performance.
- 6. Perform split-sample, paired-T testing with the Department based on project quality control testing using an AASHTO accredited lab.
  - a. Perform split-sample, paired-T analysis on all mix acceptance tests related to volumetric properties and the following background testing:
    - i. Maximum Specific Gravity of Mix
    - ii. Bulk Specific Gravity of Mix
    - iii. Bulk Specific Gravity of Coarse Aggregates
  - b. Continue until attaining successful Paired-T test results, meeting  $\alpha = 0.05$ , for a minimum of two consecutive production days.

B. Quality Control Plan (QCP)

- 1. Provide and maintain a Quality Control Plan covering all personnel, equipment, supplies, and facilities necessary to obtain samples, perform and document tests, and otherwise provide a quality product.
- 2. Submit the written QCP to the Engineer at least 10 days before beginning operations, or at the Preconstruction Conference.
- 3. The Department makes no partial payments for materials that are subject to specific quality control requirements without a QCP.
- 4. The Contractor or independent organization may operate the QCP. However, the Contractor is responsible for the QCP's administration, including compliance with the QCP and any modifications.
- 5. Address the following minimum items:
  - a. Quality control organization chart and area of responsibility and authority of each individual.
  - b. Names and qualifications of personnel as required by this Section, article "Quality Control Organization Personnel Requirements."
  - c. Provide a description of outside organizations and their services (such as testing laboratories) if employed.
  - d. Tests required to be performed, the frequency of testing, sampling locations, and location of the testing facilities.

- e. Documentation of test procedures verifying that tests are conducted in accordance with the testing plan, and that proper corrective actions are taken when required.
- f. Procedures for verifying that testing equipment is available, complies with specified standards, and is calibrated against certified standards.
- g. Procedures for verifying that tests are conducted in accordance with the appropriate ASTM and AASHTO standards.
- h. Procedures for submitting test results to the Engineer daily.
- 6. QCP elements: address all elements that affect the quality of the HMA including:
  - a. Mix Design
  - b. Aggregate Grading
  - c. Quality of Materials
  - d. Stockpile Management
  - e. Proportioning
  - f. Mixing
  - g. Placing and Finishing
  - h. Sampling and Testing Procedures
  - i. Joints
  - j. Compaction
  - k. Surface smoothness

C. Quality Control Organization

- 1. Implement the QCP by:
  - a. Establishing a separate Quality Control Organization.
  - b. Developing an organization chart to show all quality control personnel and how these personnel integrate with other management, production, and construction functions and personnel.
- 2. Identify all quality control staff on the organization chart by name and function, and indicate the total staff required to implement all elements of the quality control programs, including inspection and testing functions for different items of work.
- 3. If an outside organization or laboratory is used to implement all or part of the QCP, the personnel assigned are subject to the qualification requirements of this Section. Indicate on the organization chart which personnel are contractor employees and which are provided by an outside organization.

D. Quality Control Organization Personnel Requirements

- 1. As outlined in ASTM D 3666, Part 7, with the following modifications.
 

Quality Control Manager:

  - a. Institutes any actions necessary to successfully operate the QCP in compliance with specifications.

- b. Reports directly to a responsible officer in the Contractor's organization.
    - c. May supervise the QCP on more than one project provided that the Quality Control Manager can be at the job site within one hour after being notified of a problem.
  - 2. Certification of Personnel. As outlined in ASTM D 5506 with the following changes:
    - a. Provide a sufficient number of quality control technicians to adequately implement the QCP. These personnel will be either engineers or engineering technicians certified by WAQTC.
  - 3. Quality Control Technicians:
    - a. Report directly to the Quality Control Manager.
    - b. Inspect all plant equipment used in proportioning and mixing to verify proper calibration and operating condition.
    - c. Perform quality control tests necessary to adjust and control mix proportioning in accordance with the job mix formula.
    - d. Inspect all equipment used in placing, finishing, and compaction to verify proper operating condition.
    - e. Inspect all construction operations to verify conformance with the specifications.
    - f. Perform all quality control testing as required by this Section, article "Quality Control Testing."
    - g. Detail the criteria to be used in initiating correction of unsatisfactory production processes and construction practices.
- E. Quality Control Testing Laboratory
  - 1. Reference ASTM D 4561 with the following additions:
    - a. Provide a fully equipped asphalt laboratory located within 30 minutes travel time of the plant or job site.
    - b. Keep laboratory facilities clean and all equipment maintained in proper working condition.
    - c. Permit the Engineer unrestricted access to inspect the quality control testing laboratory facility and witness quality control activities. The Department advises in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies or testing personnel and procedures.
    - d. Suspend work when test results indicate materials are out of specification tolerances. Resume only when the deficiencies are corrected.
      - i. Perform quality audits under this standard.
      - ii. Refer to UDOT QA Manual.
  - 2. Sampling:
    - a. Use a statistically based procedure of random sampling. ASTM D 3665.

- b. The Engineer has the right to witness all sampling. UDOT Materials Manual of Instruction Part 8-984: Sampling Methods.
  - 3. Noncompliance:
    - a. When quality control activities do not comply with either the Quality Control Program or the Contract provisions, or failure to properly operate and maintain an effective Quality Control Program, the Engineer may:
      - i. Order replacement of ineffective or unqualified personnel.
      - ii. Carry out the functions and operation of the approved Quality Control Program.
      - iii. Deduct costs incurred by the Department to operate the program or otherwise remedy the noncompliance from the total amount due the Contractor.
- F. Quality Control Testing
  - 1. Perform all quality control tests necessary to control the production and construction processes applicable to these specifications and listed in the QCP.
  - 2. Establish a testing program to control as a minimum: asphalt binder content, aggregate gradation, VMA, temperatures, aggregate moisture, field compaction, and surface smoothness.
  - 3. Monitoring: The Department reserves the right to monitor any QC testing.
  - 4. Follow the requirements of Table 10, and conduct any additional testing to control the process.

**Table 10**

<b>Quality Control Testing for HMA</b>	
<b>Testing Method/ Acceptance Documentation</b>	<b>Testing Frequency</b>
AASHTO T 308 <b>Asphalt binder content:</b> by the ignition method	Minimum 4 tests per lot **
AASHTO T 30 <b>Gradation:</b> Mechanical analysis of the remains of the Ignition test.	Minimum 4 tests per lot
AASHTO T 255 <b>Moisture content:</b> of aggregate used in production by drying	Minimum One test per lot
<b>Temperature</b> for: dryer, bitumen in the storage tank, mixture at the plant, and mixture at the job site.	Record at least four times per lot
ASTM D 2950 <b>In-place Density Monitoring</b> Conduct all testing necessary to meet density requirements.	Minimum 10 density determinations per lot
AASHTO T 312, PP 28 <b>Field Gyratory Specimens</b> Verify mix design parameters meet Job-mix requirements, and adjust mix as needed to meet parameters. Mold field gyratory specimens at mix design temperatures determined by the Engineer.	Minimum of one determination (two Gyratory specimens each) of VMA and Air Voids for each lot.

\*\* A lot is defined in article 1.4

G. Control Charts

1. Maintain daily linear control charts both for mean and range. Include in charts aggregate gradation, asphalt binder content, stockpile gradation, VMA, Density and in-place air voids.
2. Post control charts daily in a location satisfactory to the Engineer. As a minimum, identify:
  - a. Project number
  - b. Contract item number
  - c. Test number
  - d. Each test parameter

- e. Test results
  - 3. Use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the projected data during production indicates a problem and no corrective action is taken, the Engineer may suspend production or acceptance of the material.
- H. Quality Control Reports
- 1. Maintain records and submit daily reports of quality control activities.

### **3.9 DISPUTE RESOLUTION**

- A. When disputing the validity of the Department's acceptance tests, submit an engineering analysis within one week of receipt of test results.
- B. At a minimum, include the following items in the engineering analysis:
  - 1. Data supporting the Contractor's test results. Data must be based on project quality control testing performed by an AASHTO accredited lab that has performed a split-sample process with the Department and includes:
    - a. Split-sample testing performed within the applicable contract
    - b. Test data disputed along with:
      - i. Maximum Specific Gravity of Mix
      - ii. Bulk Specific Gravity of Mix
      - iii. Bulk Specific Gravity of Coarse Aggregates
    - c. Successful Paired-T test information, meeting  $\alpha = 0.05$ , for a minimum of two consecutive production days
  - 2. Procedures or issues leading to disputed acceptance test results.
  - 3. Determination of volumetric, durability and long-term structural properties from one or more of the following tests:
    - a. Hamburg Rut Tester
    - b. 5-Cycle Lottman
    - c. Asphalt Pavement Analyzer - Rut and Fatigue tests
    - d. Resilient Modulus
    - e. SHRP PG Asphalt Binder Tests
    - f. SHRP Gyrotory Compactor
  - 4. Incentive/Disincentive calculations based on Contractor and Department test values.
  - 5. Recommendations for price adjustment based on expected long-term performance.
- C. When paving plans indicate that a reject lot will be covered within 48 hours, the Department immediately reviews the analysis to identify possible discrepancies that can be resolved through validation testing based on the following:

1. Department performs repeat testing on remaining material from original Department test.
  2. Department personnel perform repeat testing in the presence of Contractor representative within a 24 hour time period.
  3. Use results to validate or invalidate original Department result. Validation test results may not be used in lieu of acceptance results.
  4. Base validation on results within two standard deviations (project acceptance samples) of original acceptance result. Remove invalidated test results from acceptance lot and reevaluate lot based on reduced sample size.
  5. The Engineer reviews the results and notifies the Contractor of any findings that affect the reject status of the lot along with the Department's position on whether the lot is to be removed or may remain in place at the \$15.00/ton deduction for Reject Lot.
- D. Within three working days of receipt, the Resident Engineer, Region Materials Engineer, and Region Construction Engineer review the analysis and notify the Contractor in writing of acceptance or rejection. Notification of rejection includes the following:
1. Engineering basis for rejecting the Contractor's analysis, including specific points of objection.
  2. Department data and analysis to justify Department position.
  3. Time frame for removal of material or pay adjustment to be applied to the lot.
- E. When the Department concludes the engineering analysis has merit, the Department, in conjunction with the Contractor, immediately begins a review of the acceptance test results. The review includes, but is not be limited, to the following:
1. Independent Assurance review of all equipment and procedures and methods used for sampling, splitting, and testing.
  2. A review of the Department and Contractor's raw test data and calculations for documentation or calculation errors.
  3. Production and testing of additional correlation samples.
  4. Cross-witnessing of test procedures by Contractor Quality Control and Department personnel.
  5. Distribution any other pertinent information.
  6. Discussion of other possible means for variation.

*Note: If engineering analysis is initiated due to failure of statistical methods to verify Contractor testing and there is no net difference between incentive/disincentive based on Contractor or Department testing, the Engineer may verify contractor test values based on engineering analysis.*

- F. Do not continue production without concurrence from the Engineer or until differences in the test results are resolved.
- G. If errors in testing or reporting are discovered, the Department corrects the applicable test results and re-applies the acceptance/pay adjustment procedures.
  - 1. If errors are identified that cannot be corrected and the quality of the lot is in question, the Department may choose to evaluate the lot using the Hamburg Wheel Tracker or the Asphalt Pavement Analyzer.
    - a. Use 5 stratified random samples cut from the roadway
    - b. The Region Materials Engineer and Resident Engineer decide, in conjunction with the Contractor, the status of the lot and associated pay adjustment, based on the following:
      - i. Fatigue Life
      - ii. Stripping Potential
      - iii. Rutting Potential
      - iv. Expected Pavement Performance Period vs. Design Life
  - 2. Errors that are identified within the Department's testing result in a review of the Contractor's schedule and if appropriate, make adjustments to the CPM.
- H. If errors in testing cannot be identified, select an Independent Third Party (Agreed on by the Department and the Contractor) to witness sample splitting and testing by both the Contractor and the Department. The Independent Third Party identifies/produces additional material for split-sample testing.
- I. If testing errors are identified by the Third Party, the Department makes appropriate adjustments to the acceptance test results and re-applies the acceptance/pay adjustment procedures.
- J. The party responsible for the identified error pays for the services of the Independent Third Party.
- K. If no errors are identified, the Department evaluates the lot using the original testing results.

**Table 11**

<b>National Highway System and Truck Routes Category 1</b>		
<b>Interstate Routes</b>	<b>Beginning</b>	<b>Ending</b>
<b>1-15</b>	Arizona State Line	Idaho State Line
<b>1-70</b>	Jct I-70 - Cove Fort	Colorado State Line
<b>1-80</b>	Nevada State Line	Wyoming State Line
<b>1-84</b>	Idaho State Line	Jct I-80 - Coalville
<b>1-215</b>	Jct I-80 - Parleys Canyon	Jct I-15 - North Salt Lake
<b>US Routes</b>		
<b>US-6</b>	Nevada State Line	Jct US-50 - Delta
<b>US-6</b>	Jct I-15 - Spanish Fork	Jct I-70 - Green River
<b>US-40</b>	Jct I-80 - Park City	Colorado State Line
<b>US-50</b>	Jct US-6 - Delta	Jct I-15 - Holden
<b>US-89</b>	Arizona State Line	Jct I-70 - Sevier
<b>US-89</b>	Jct I-70 - Salina	Jct SR-28 - Gunnison
<b>US-89</b>	Jct US-6 - Spanish Fork	Jct SR-73 - Lehi
<b>US-89</b>	Jct I-15 - Draper, Exit 295	Jct SR-269 - 5 <sup>th</sup> and 6 <sup>th</sup> South
<b>US-89</b>	Jct I-15 - Farmington	Jct I-80 - Uintah
<b>US-89</b>	Jct I-84 - Uintah	Jct SR-134 - North Ogden
<b>US-89</b>	Jct US-91 - Logan	Idaho State Line
<b>US-91</b>	Jct I-15 - Brigham City	Jct US-89 - Logan
<b>US-189</b>	Jct I-15 - South Provo	Jct US-40 - Heber City
<b>US-191</b>	Arizona State Line	Jct I-70 - Thompson
<b>US-666</b>	Jct US-191 - Monticello	Colorado State Line

<b>State Routes</b>	<b>Beginning</b>	<b>Ending</b>
<b>SR-9 - Zions Park</b>		
<b>SR-10 - Castle Valley</b>	Jct I-70 - Fremont Jct	Jct US-6 - Price
<b>SR-12 - Bryce Canyon</b>	Jct US-89 - Panguitch	Jct SR-63 - Bryce Canyon
<b>SR-26 – Riverdale Road</b>	Jct I-15 - Exit 342	Jct US-89 - Ogden
<b>SR-28 - Levan Desert</b>	Jct US-89 - Gunnison	Jct I-15 - South Nephi
<b>SR-31 - Huntington</b>	Mile Post 33	Mile Post 49
<b>SR-36 - Tooele Access</b>	Jct entrance - Tooele Army Depot	Jct I-80 - Tooele Interchange
<b>SR-39 - 20<sup>th</sup> and 21<sup>st</sup> Ogden</b>	Jct I-15 - Exit 344	Jct SR-203 - Harrison Blvd
<b>SR-52 - 8<sup>th</sup> North, Orem</b>	Jct I-15 - Orem	Jct US -189 - Olmstead Jct
<b>SR-57 - Orangeville Bypass</b>	Jct SR-10 - Hunter Power Plant	Entrance - Wilberg Coal Mine
<b>SR-71 - 7<sup>th</sup> and 9<sup>th</sup> East Street, Salt Lake City</b>	Jct SR0-209 - 90th South Street	Jct SR-186 - 4 <sup>th</sup> South Street
<b>SR-73 - Lehi Connection</b>	Jct I-15 - South Lehi	Jct US-89 - South Lehi
<b>SR-79 - 12<sup>th</sup> Street Ogden</b>	Jct I-15 - Exit 347	Jct SR-203 - Harrison Blvd.
<b>SR-96 - Scofield Access</b>	Mile Post 3	Mile Post 4
<b>SR-111 - Bacchus Highway</b>	Jct SR-48 - Bingham Highway	Jct SR-201 - 21 <sup>st</sup> South Expressway
<b>SR-134 - 2700 North</b>	Jct I-15 - North Ogden, Exit 352	Jct US-89 - North Ogden
<b>SR-152 - Van Winkle Expressway</b>	Jct SR-71 - 9th East Street	Jct I-215 - East (Exit 8)
<b>SR-154 - Bangerter Highway</b>	Jct I-15 - Draper	Jct I-80 - Salt Lake Intl Airport
<b>SR-171 - 33<sup>rd</sup> and 35<sup>th</sup> South, Salt Lake City</b>	Jct SR-172 - 56 <sup>th</sup> West Street	Jct I-215 - East, Exit 3
<b>SR-172 - 56<sup>th</sup> West Street Salt Lake City</b>	Jct 6200 South - Kearns	Jct I-80 - International Center
<b>SR-186 Foothill Blvd</b>	Jct SR-71 - 7 <sup>th</sup> East Street, SLC	Jct I-215 - East (Exit 1)
<b>SR-190 - Big Cottonwood</b>	Jct I 215 - East, Exit 7, SLC	Jct SR-210 - Little Cottonwood
<b>SR-201 - 21<sup>st</sup> South Expressway</b>	Jct I-80 - Lake Point	Jct I-15 - South Salt Lake
<b>SR-203 - Harrison Blvd</b>	Jct US-89 - South Ogden	Jct SR-39 - 12 <sup>th</sup> Street

<b>State Routes</b>	<b>Beginning</b>	<b>Ending</b>
<b>SR-209 - 90<sup>th</sup> &amp; 94<sup>th</sup> South</b>	Jct SR-68 - Redwood Road (SLC)	Jct SR-210 - Little Cottonwood
<b>SR-210 - Little Cottonwood</b>	Jct SR-190 - Big Cottonwood	Jct SR-209 - 90 <sup>th</sup> and 96 <sup>th</sup> South
<b>SR-264 - Skyline Mine Road</b>	Mile Post 12	Mile Post 15
<b>SR-265 - University Parkway</b>	Jct I-15 - Exit 272	Jct I-215 East, Exit 5
<b>SR-266 - 45<sup>th</sup> &amp; 47<sup>th</sup> South Taylorsville</b>	Jct I-215 - West, Exit 15	Jct I-215 - East, Exit 5
<b>SR-269 - 5<sup>th</sup> &amp; 6<sup>th</sup> South Salt Lake City</b>	Jct I-215, Exit 310	Jct SR-71 - 7 <sup>th</sup> East Street

END OF SECTION

**Change One - August 29, 2002**

**Revised Articles**

3.8 E 2 a

3.8 E 2 b

**Change Two – December 19, 2002**

**No changes made**

**Change Three – February 27, 2003**

**Revised Articles**

1.4 C6a added

1.4 H

Table 3

2.4 A

2.4 C

Table 9

2.5 B 1-3

2.5 B 4 added

2.5 D

3.1 A1 deleted

3.2 C3 added

3.7 D1

3.9 B4

3.9 B5 added

3.9 E note added

Hot Mix Asphalt (HMA)

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February 27, 2003

## **SECTION 02745**

# **ASPHALT MATERIAL**

## **PART 1 GENERAL**

### **1.1 SECTION INCLUDES**

- A. Asphalt materials.

### **1.2 PAYMENT PROCEDURES**

- A. Price adjustments for asphaltic cement and liquid asphalt (chip-seal emulsions and/or cut-backs):
  - 1. Standard department procedures governs price adjustments made where asphalt material does not conform to the specifications
    - a. If the price adjustment exceeds 30 percent, the Engineer may order the removal of any or all the defective asphalt material.
    - b. The pay factor for such material is 0.50 when allowed to remain in place.
- B. Price adjustments for Performance Graded Asphalt Binder (PGAB):
  - 1. Standard department PGAB management plan governs price reductions or removal of material where they binder does not conform to the specifications.

### **1.3 REFERENCES**

- A. AASHTO M 81: Cut-Back Asphalt (Rapid-Curing Type).
- B. AASHTO M 82: Cut-Back Asphalt (Medium-Curing Type).
- C. AASHTO M 140: Emulsified Asphalt.
- D. AASHTO M 208: Cationic Emulsified Asphalt.
- E. AASHTO M 226: Viscosity Graded Asphalt Cement.
- F. AASHTO MP 1: Performance Graded Asphalt Cement.

- G. AASHTO T 44: Solubility of Bituminous Materials.
- H. AASHTO T 49: Penetration of Bituminous Materials.
- I. AASHTO T 50: Float Test for Bituminous Materials.
- J. AASHTO T 51: Ductility of Bituminous Materials.
- K. AASHTO T 59: Testing Emulsified Asphalt.
- L. AASHTO T 201: Kinematic Viscosity of Asphalts.
- M. AASHTO T 228: Specific Gravity of Semi-Solid Bituminous Materials.
- N. AASHTO T 240: Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-Film Oven Test).
- O. AASHTO T 300: Force Ductility of Bituminous Materials.
- P. AASHTO T 301: Elastic Recovery Test of Bituminous Materials by Means of a Ductilometer.
- Q. ASTM D 92: Flash and Fire Points by Cleveland Open Cup.
- R. ASTM D 1190: Concrete Joint Sealer, Hot-Applied Elastic Type.
- S. ASTM D 2007: Characteristic Groups in Rubber Extender and Processing Oils and Other Petroleum-Derived Oils by the Clay-Gel Absorption Chromatographic Method.
- T. ASTM D 2026: Cutback Asphalt (Slow-Curing Type).
- U. ASTM D 3405: Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements.
- V. ASTM D 4402: Viscosity Determinations of Unfilled Asphalts Using the Brookfield Thermosel Apparatus.
- W. ASTM D 5167: Melting of Hot-Applied Joint and Crack Sealant and Filler for Evaluation.
- X. ASTM D 5329: Sealants and Fillers, Hot-Applied, For Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements.
- Y. ASTM D 5801: Toughness and Tenacity of Bituminous Materials.

## **1.4 SUBMITTALS**

- A. For each shipment of material, supply a vendor-prepared bill of lading showing the following information:
  - 1. Type and grade of material
  - 2. Type and amount of additives, used, if applicable
  - 3. Destination
  - 4. Consignee's name
  - 5. Date of Shipment
  - 6. Railroad car or truck identification
  - 7. Project number
  - 8. Loading temperature
  - 9. Net weight in tons (or net gallons corrected to 60 degrees F, when requested)
  - 10. Specific gravity
  - 11. Bill of lading number
  - 12. Manufacturer of asphalt material

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Each shipment of asphalt material must:
  - 1. Be uniform in appearance and consistency.
  - 2. Show no foaming when heated to the specified loading temperature.
- B. Do not supply shipments contaminated with other asphalt types or grades than those specified.

## **1.6 GRADE OF MATERIAL**

- A. The Engineer determines the grade of material to be used based on the supply source designated by the Contractor when the bid proposal lists more than one grade of asphalt material.

## **PART 2 PRODUCTS**

### **2.1 PERFORMANCE GRADED ASPHALT BINDER (PGAB)**

- A. Supply PGABs under the Approved Supplier Certification (ASC) System. Refer to UDOT Asphalt Binder Quality Management Plan.

- B. As specified in AASHTO MP 1, with the following modifications:
1. Delete superscript (f) for all specified grades having algebraic differences of 92 degrees C or greater between the high and low design temperatures.
  2. Add Direct Tension Test for all specified grades having algebraic differences of 92 degrees C or greater between the high and low design temperatures.
    - a. Failure Strain, minimum of 1.5 percent at 1.0 mm/min.
    - b. Failure Stress, minimum of 4.0 Mpa
  3. Delete  $G^*/\sin \delta$  requirement for the original binder on all specified grades having algebraic differences of 92 degrees C or greater between the high and low design temperatures.
  4. Add  $G^*$  and phase angle ( $\delta$ ) requirements for the original binder on all specified grades having an algebraic difference of 92 degrees C between the high and low design temperatures.
    - a.  $G^*$  (complex modulus), 1.3 kPa, minimum
    - b. Phase angle ( $\delta$ ), 74 degrees, maximum
  5. Add  $G^*$  and phase angle ( $\delta$ ) requirements for the original binder on all specified grades having an algebraic difference of 98 degrees C or greater between the high and low design temperatures.
    - a.  $G^*$  (complex modulus), 1.3 kPa, minimum
    - b. Phase angle ( $\delta$ ), 71 degrees, maximum
  6. Add Toughness and Tenacity Test for all specified grades having algebraic differences of 92 degrees C or greater between the high and low design temperatures.
    - a. Meet a minimum of 75 lb-in 50 lb-in respectively for each test specimen.

## 2.2 ASPHALTIC CEMENT, LIQUID ASPHALTS, REJUVENATING AGENTS

- A. As specified in AASHTO M 226, Table 2 with the following modifications:
1. Delete and replace ductility at 77EF(25EC) with ductility at 39.2EF(4EC) with values as detailed below.

<u>AC - 2.5</u>	<u>AC - 5</u>	<u>AC - 10</u>	<u>AC - 20</u>
50+	25+	15+	5+

- B. As specified for cationic and anionic emulsified asphalt.
1. All standard Slow Setting (SS, CSS), Medium Setting (MS, CMS), and Rapid Setting (RS, CRS) grades; inclusive of all High-Float designations (HF).
  2. Supply under the Approved Supplier Certification System (ASC).
  3. Meet AASHTO M 208 and M 140.

- C. Conform to the requirements of:
1. Table 1: Cationic Rapid Setting Emulsified Polymerized Asphalt (CRS-2P); or
  2. Table 2: Latex Modified Cationic Rapid Setting Emulsified Asphalt (LMCRS-2); or
  3. Table 3: Cationic Medium Setting Emulsified Asphalt (CMS-2S); or
  4. Table 4: High Float Medium Setting Emulsified Polymerized Asphalt (HRMS-2SP); or
  5. Table 5: High Float Rapid Setting Emulsified Polymerized Asphalt (HFRS-2P); or
  6. Table 6: Cationic Rapid Setting Emulsified Asphalt (CRS-2A, B).
- D. Curing cut-back asphalt:
1. As specified for slow curing (SC) in ASTM D 2026.
  2. As specified for medium curing (MC) in AASHTO M 82.
  3. As specified for rapid curing (RC) in AASHTO M 81.
- E. Conform to requirements for Emulsified Asphalt Pavement Rejuvenating Agent:
1. Table 7: Type B
  2. Table 8: Type B Modified
  3. Table 9: Type C
  4. Table 10: Type D

**Table 1**

<b>Cationic Rapid Setting Emulsified Polymerized Asphalt (CRS-2P)</b>			
<b>Tests</b>	<b>AASHTO Test Method</b>	<b>Min.</b>	<b>Max.</b>
<b>Emulsion</b>			
Viscosity , SFS, 140EF (60EC), sec (Project-site Acceptance/Rejection Limits)	T 59	100	400
Settlement (a) 5 days, percent	T 59		5
Storage Stability Test (b) 1 d, 24 h, percent	T 59		
Demulsibility (c) 35 ml, 0.8% sodium dioctyl Sulfosuccinate, percent	T 59	40	
Particle Charge Test	T 59	Positive	
Sieve Test, percent	T 59		0.10
<b>Distillation</b>			
Oil distillate, by vol of emulsion, percent			0
Residue (d), percent		68	
<b>Residue from Distillation Test</b>			
Penetration, 77EF(25EC), 100 g, 5 s, dmm	T 49	80	150
Ductility, 39.2EF(4EC), 5 cm/min, cm	T 51	35	
Toughness, lb-in	ASTM D5801	75	
Tenacity, lb-in	ASTM D5801	50	
Solubility in trichloroethylene, percent	T 44	97.5	
<p>(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than a five-day time; or the purchaser may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 days.</p> <p>(b) The 24-hour (1-day) storage stability test may be used instead of the five-day settlement test.</p> <p>(c) The demulsibility test is made within 30 days from date of shipment.</p> <p>(d) Distillation is determined by AASHTO T 59, with modifications to include a <math>350 \pm 5</math> EF (<math>177 \pm 3</math>EC) maximum temperature to be held for 15 minutes.</p> <p>Modify the asphalt cement prior to emulsification.</p>			

**Table 2**

<b>Latex Modified Cationic Rapid Setting Emulsified Asphalt (LMCRS-2)</b>			
<b>Tests</b>	<b>AASHTO Test Method</b>	<b>Min.</b>	<b>Max.</b>
<b>Emulsion</b>			
Viscosity, SFS, 122 EF (50 EC), Sec (Project Site Acceptance/Rejection Limits)	T59	75	300
Settlement (a) 5 days, percent	T 59		5
Storage Stability Test (b) 1 d, 24 h, percent	T 59		1
Demulsibility (c) 35 ml, 0.8% sodium dioctyl Sulfosuccinate, percent	T 59	40	
Particle Charge Test	T 59	Positive	
Sieve Test, percent	T 59		0.3
<b>Distillation</b>			
Oil distillate, by vol of emulsion, percent			0
Residue (d), percent		65	
<b>Residue from Distillation Test</b>			
Penetration, 77EF (25EC), 100 g, 5 s, dmm	T 49	80	150
Ductility, 39.2 EF (4 EC), 5 cm/min, cm	T51	35	
Toughness, lb-in	ASTM D5801	75	
Tenacity, lb-in	ASTM D5801	50	
<p>(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than a five-day time; or the purchaser may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 days.</p> <p>(b) May use the 24-hour (1-day) storage stability test instead of the five-day settlement test.</p> <p>(c) Make the demulsibility test within 30 days from date of shipment.</p> <p>(d) Determine distillation by AASHTO T 59, with modifications to include a <math>350 \pm 5</math> EF (<math>177 \pm 3</math>EC) maximum temperature to be held for 15 minutes.</p>			
<b>Co-mill latex and asphalt during emulsification</b>			

**Table 3**

<b>Cationic Medium Setting Emulsified Asphalt (CMS-2S)</b>		
<b>Tests</b>	<b>AASHTO Test Method</b>	<b>Specification</b>
<b>Emulsion</b>		
Viscosity, SSF, 122EF (50EC), sec.	T 59	50 - 450
Percent residue	T 59	60 min
One-day storage stability, percent	T 59	1 max
Sieve, percent	T 59	0.10 max
Particle charge	T 59	Positive
Oil Distillate, percent by volume of emulsion	T 59	5-15
<b>Residue</b>		
Penetration, 77EF (25EC), 100g, 5 sec, dmm	T 59	100-250
Solubility, percent	T 59	97.5 min.

**Table 4**

<b>High Float Medium Setting Emulsified Polymerized Asphalt (HFMS-2P) (a)</b>			
<b>Tests</b>	<b>AASHTO Test method</b>	<b>Min.</b>	<b>Max.</b>
<b>Emulsion</b>			
Viscosity , SSF ,122EF (50EC), sec (Project Site Acceptance/Rejection Limits)	T 59	50	450
Storage Stability Test (a) 1 d, 24 h, percent	T 59		0.1
Sieve Test, percent	T 59		0.1
<b>Distillation</b>			
Oil distillate, by vol of emulsion, percent	T 59	1	7
Residue (c), percent	T 59	65	
<b>Residue from Distillation Test</b>			
Penetration, 77EF (25EC), 100 g, 5 s, dmm	T 49	70	300
Float Test, 140EF (60EC), sec	T 50	1200	300
Solubility in trichloroethylene, percent	T 44	97.5	
Elastic Recovery, 77EF (25EC), percent	T 301	50	
<p>(a) Supply an HFMS-2SP (anionic, polymerized, high-float) as an emulsified blend of polymerized asphalt cement, water, and emulsifiers. Polymerize the asphalt cement with a minimum of 3.0% polymer by weight of the asphalt cement prior to emulsification. After standing undisturbed for a minimum of 24 hours, the emulsion shall be smooth and homogeneous throughout with no white, milky separation, pumpable, and suitable for application through a distributor.</p> <p>(b) May use the 24-hour (1-day) storage stability test instead of the five-day settlement test.</p> <p>(c) Determine the distillation by AASHTO T 59, with modifications to include a <math>350 \pm 5</math> EF (177<math>\pm</math>3EC) maximum temperature to be held for 15 minutes.</p>			

**Table 5**

<b>High Float Rapid Setting Emulsified Polymerized Asphalt (HFRS-2P) (a)</b>			
<b>Tests</b>	<b>AASHTO Test method</b>	<b>Min.</b>	<b>Max.</b>
<b>Emulsion</b>			
Viscosity, SFS @ 122EF (50EC), sec (Project Site Acceptance/Rejection Limits)	T 59	50	450
Storage Stability Test (a) 1 d, 24 h, percent	T 59		1
Demulsibility (b) 0.02 N Ca Cl <sub>2</sub> , percent	T 59	40	
Sieve Test, percent	T 59		0.1
<b>Distillation</b>			
Oil distillate, by vol of emulsion, percent	T 59		3
Residue (c), percent	T 59	65	
<b>Residue from Distillation Test</b>			
Penetration, 77EF (25EC), 100 g, 5 s, dmm	T 49	70	150
Float Test, 140EF (60EC), sec	T 50	1200	
Solubility in trichloroethylene, percent	T 44	97.5	
Elastic Recovery, 77EF (25EC), percent	T 301	58	
<p>(a) Supply an HFMS-2SP (anionic, polymerized, high-float) as an emulsified blend of polymerized asphalt cement, water, and emulsifiers. Polymerize the asphalt cement with a minimum of 3.0% polymer by weight of the asphalt cement prior to emulsification. After standing undisturbed for a minimum of 24 hours, the emulsion shall be smooth and homogeneous throughout with no white, milky separation, pumpable, and suitable for application through a distributor.</p> <p>(b) May use the 24-hour (1-day) storage stability test instead of the five-day settlement test.</p> <p>(c) Determine the distillation by AASHTO T 59, with modifications to include a 350 ± 5 EF (177±3EC) maximum temperature to be held for 15 minutes.</p>			

**Table 6**

<b>Cationic Rapid Setting Emulsified Asphalt (CRS-2A,B)</b>			
<b>Tests</b>	<b>AASHTO Test Method</b>	<b>Min</b>	<b>Max</b>
<b>Emulsion</b>			
Viscosity, SSF, 122EF (50EC), sec (Project Site Rejection/Acceptance Limits)	T 59	140	400
Storage stability test, 24 h, percent	T 59		1
Demulsibility, 35 mL 0.8 percent Sodium Dioctyl Sulfosuccinate, percent	T 59	40	
Particle charge test	T 59	Positive	
Sieve test, percent	T 59		0.10
<b>Distillation</b>			
Oil distillate, by volume of emulsion, percent	T 59		0
Residue, percent	T 59	65	
Use PG58-22 and PG64-22 as base asphalt cement for CRS-2A, B, respectively. Specification for high temperature performance: original and RTFO G*/sin* within 3 EC of grade.			

**Table 7**

<b>Emulsified Type B Asphalt Pavement Rejuvenating Agent Concentrate</b>		
<b>Tests</b>	<b>Test Method</b>	<b>Limits</b>
Viscosity, SSF, 77EF (25EC), sec	AASHTO T 59	25-150
Residue, percent W	AASHTO T 59 (mod) (a)	62 Min.
Sieve Test, percent W	AASHTO T 59	0.10 Max.
5-day Settlement	AASHTO T 59	5.0 Max.
Particle Charge	AASHTO T 59	Positive
Pumping Stability (b)		Pass
<b>Residue from Distillation (a)</b>		
Viscosity @ 140EF(60EC), mm <sup>2</sup> /s	AASHTO T 201	2500-7500
Solubility in 1,1,1 Trichloroethylene, percent	AASHTO T 44	98 Min.
Flash Point, COC	ASTM D 92	204 EC, Min.
Asphaltenes, percent W	ASTM D 2007	15 Max.
Saturates, percent W	ASTM D 2007	30 Max.
Aromatics, percent W	ASTM D 2007	25 Min.
Polar Compounds, percent W	ASTM D 2007	25 Min.
(a) Determine the distillation by AASHTO T-59 with modifications to include a 300 ± 5 EF (149±3EC) maximum temperature to be held for 15 minutes.		
(b) Test pumping stability by pumping 475 ml of Type B diluted 1 part concentrate to 1 part water, at 77EF (25EC) through a 1/4 inch gear pump operating at 1750 rpm for 10 minutes with no significant separation or coagulation in pumped material.		
Type B: an emulsion of lube oil and/or lube oil extract blended with petroleum asphalt.		

**Table 8**

<b>Emulsified Type B Modified Asphalt Pavement Rejuvenating Agent Concentrate</b>		
<b>Property</b>	<b>Test Method</b>	<b>Limits</b>
Viscosity, SSF, 77EF (25EC), sec	AASHTO T 59	50-200
Residue by distillation or Evaporation (a), percent W	AASHTO T 59	62 Min.
Sieve Test, percent W	AASHTO T 59	0.20 Max.
5-day Settlement, percent W	AASHTO T 59	5.0 Max.
Particle Charge	AASHTO T 59	Positive
Pumping Stability (b)		Pass
<b>Residue from Distillation (a)</b>		
Viscosity (c) 275EF (135 EC), cP	ASTM D 4402	150 - 300
Penetration, 77EF (25EC), dmm	AASHTO T 49	180 Min.
Solubility in 1,1,1 Trichloroethylene, percent	AASHTO T 44	98 Min.
Flash Point, COC, EF (EC)	AASHTO T 48	400(204) Min.
Asphaltenes, percent W	ASTM D 2007	20-40
Saturates, percent% W	ASTM D 2007	20 Max.
Polar Compounds, percent W	ASTM D 2007	25 Min.
Aromatics, percent W	ASTM D 2007	20 Min.
PC/S Ratio	ASTM D 2007	1.5 Min.
<p>(a) Determine the distillation by AASHTO T-59 with modifications to include a 300±5EF (149 ± 3EC) maximum temperature to be held for 15 minutes.</p> <p>(b) Pumping stability is tested by pumping 475 ml of Type B diluted 1 part concentrate to 1 part water, at 77EF (25 EC) through a 1/4 inch gear pump operating at 1750 rpm for 10 minutes with no significant separation or coagulation in pumped material.</p> <p>(c) Brookfield Thermocel Apparatus-LV model at 6 rpm with a #28 spindle at 2-98 torque.</p> <p>As required by the Asphalt Emulsion Quality Management system (Materials Manual Part 8-208), the supplier certifies that the base stock contains a minimum of 15 % by weight of Gilsonite Ore. Use the HCL precipitation method as a qualitative test to detect the presence of Gilsonite.</p>		

**Table 9**

<b>Emulsified Type C Asphalt Pavement Rejuvenating Agent Concentrate</b>		
<b>Property</b>	<b>Test Method</b>	<b>Limits</b>
Viscosity, SFS, 77EF (25EC), sec	AASHTO T 59	10-100
Residue (a), percent W (Type C supplied ready to use 1:1 or 2:1.	AASHTO T 59 (a)	30 Min. 1:1 40 Min. 2:1
Sieve Test, percent W (b)		0.10 Max.
5-day Settlement, percent W	AASHTO T 59	5.0 Max.
Particle Charge	AASHTO T 59	Positive
pH (May be used if particle charge test is inconclusive)		2.0 - 7.0
Pumping Stability (c)		Pass
<b>Tests of Residue from Distillation (a)</b>		
Viscosity, 275EF (135EC), mm <sup>2</sup> /s	AASHTO T 201	475-1500
Solubility in 1,1,1 Trichloroethylene, percent	AASHTO T 44	97.5 Min.
RTFO mass loss, percent W	AASHTO T 240	2.5 Max.
Specific Gravity	AASHTO T 228	0.98 Min.
Flash Point, COC	AASHTO T 48	232 EC, Min.
Asphaltenes, percent W	ASTM D 2007	25 Min., 45 Max.
Saturates, percent W	ASTM D 2007	10 Max.
Polar Compounds, percent W	ASTM D 2007	30 Min.
Aromatics, percent W	ASTM D 2007	15 Min.
<p>(a) Determine the distillation by AASHTO T-59 with modifications to include a 300± 5EF (149 ± 3EC) maximum temperature to be held for 15 minutes.</p> <p>(b) Test method identical to AASHTO T 59 except that distilled water is used in place of 2 % sodium oleate solution.</p> <p>(c) Test pumping stability by pumping 475 ml of Type diluted 1 part concentrate to 1 part water, at 77EF (25EC) through a 1/4 inch gear pump operating at 1750 rpm for 10 minutes with no significant separation or coagulation in pumped material.</p>		
As required by the Asphalt Emulsion Quality Management system (Materials Manual Part 8-208), the supplier certifies that the base stock contains a minimum of 10 % by weight of Gilsonite ore. Use the HCL precipitation method as a qualitative test to detect the presence of Gilsonite.		

**Table 10**

<b>Emulsified Type D Asphalt Pavement Rejuvenating Agent Concentrate</b>		
<b>Property</b>	<b>Test Method</b>	<b>Limits</b>
Viscosity, SFS, 77EF (25EC), sec	AASHTO T 59	30-90
Residue, (a) percent W	AASHTO T 59 (mod) (a)	65
Sieve Test, percent W	AASHTO T 59	0.10 Max.
pH		2.0 - 5.0
<b>Residue from Distillation (c)</b>		
Viscosity, 140EF (60EC), cm <sup>2</sup> /s	AASHTO T 201	300-1200
Viscosity, 275EF (135EC), mm <sup>2</sup> /s	AASHTO T 201	300 Min.
Modified Torsional Recovery (b)	CA 332 (Mod)	40 % Min.
Toughness, 77EF (25EC), in-lb	ASTM D 5801	8 Min.
Tenacity, 77EF (25EC), in-lb	ASTM D 5801	5.3 Min.
Asphaltenes, percent W	ASTM D 2007	16 Max.
Saturates, percent W	ASTM D 2007	20 Max.
(a) California test method #331 for recovery of residue. (b) Torsional recovery measurement to include first 30 seconds. (c) Determine the distillation by AASHTO T-59 with modifications to include a 300±5EF (149 ± 3EC) maximum temperature to be held for 15 minutes.		

## 2.3 HOT-POUR CRACK SEALANT FOR BITUMINOUS CONCRETE

- A. Combine a homogenous blend of materials to produce a sealant meeting properties and tests in Table 11.
- B. Packaging and Marking: Supply sealant pre-blended, pre-reacted, and pre-packaged in lined boxes weighing no more than 30 lb.
  1. Use a dissolvable lining that will completely melt and become part of the sealant upon subsequent re-melting.
  2. Deliver the sealant in the manufacturer's original sealed container. Clearly mark each container with the manufacturer's name, trade name of sealant, batch or lot number, and recommended safe heating and application temperatures.

**Table 11**

<b>Hot-Pour Bituminous Concrete Crack Sealant</b>			
<b>Application Properties:</b>			
Workability:	Pour readily and penetrate 0.25 in and wider cracks for the entire application temperature range recommended by the manufacturer.		
Curing:	No tracking caused by normal traffic after 45 minutes from application.		
Asphalt Compatibility: ASTM D 5329, Sec 14.	No failure in adhesion. No formation of an oily ooze at the interface between the sealant and the bituminous concrete or softening or other harmful effects on the bituminous concrete.		
Material Handling:	Follow the manufacturer's safe heating and application temperatures.		
<b>Test Method</b>	<b>Property</b>	<b>Minimum</b>	<b>Maximum</b>
AASHTO T51	Ductility, modified, 1cm/min, 39.2EF (4EC), cm	30	
UDOT method 967	Cold Temperature Flexibility	no cracks	
AASHTO T 300 (a)	Force-Ductility, lb force		4
ASTM D 5329	Flow 140EF (60EC), 5 hrs 75 E angle, mm		3
ASTM D 3405 (b)	Tensile-Adhesion, modified	300%	
AASHTO T 228	Specific Gravity, 60EF(15.6EC)		1.140
ASTM D 5329	Cone Penetration, 77EF(25EC), 150 g, 5 sec., dmm		90
ASTM D 5329	Resilience, 77EF(25EC), 20 sec., percent	30	
ASTM D 4402	Viscosity, 380EF(193.3EC), SC4-27 spindle, 20 rpm, cP		2500
ASTM D 5329	Bond as per ASTM D 1190, Section 6.4		Pass
(a) Maximum of 4 lb force during the specified elongation of 30 cm @ 1 cm/min, 39.2EF (4 EC).			
(b) Use ASTM D 3405, Section 6.4.1. Delete bond and substitute tensile-adhesion test in accordance to D 5329.			

**PART 3      EXECUTION      Not used.**

END OF SECTION

**Change One - August 29, 2002**  
**No changes made**

**Change Two - December 19, 2002**  
**No changes made**

**Change Three – February 27, 2003**  
**Revised Articles**  
**1.4 A9**

## **SECTION 02785**

# **CHIP SEAL COAT**

### **PART 1 GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Materials and procedures for applying liquid or emulsified asphalt on a cleaned surface followed with an application of cover material and bituminous flush coat.
- B. Cover materials.

#### **1.2 RELATED SECTIONS**

- A. Section 01455: Materials Quality Requirements
- B. Section 01558: Temporary Pavement Markings
- C. Section 02745: Asphalt Material
- D. Section 02748: Prime Coat/Tack Coat

#### **1.3 REFERENCES**

- A. AASHTO M 140: Emulsified Asphalt.
- B. AASHTO M 208: Cationic Emulsified Asphalt.
- C. AASHTO MP 1: Performance Graded Asphalt Binder
- D. AASHTO T 11: Materials Finer Than 75 Fm (No. 200) Sieve in Mineral Aggregates by Washing.
- E. AASHTO T 19: Unit Weight and Voids in Aggregate.
- F. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates.
- G. AASHTO T 40: Sampling Bituminous Materials.

- H. AASHTO T 96: Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine.
- I. AASHTO T 104: Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
- J. AASHTO T 278: Surface Frictional Properties Using the British Pendulum Tester.
- K. AASHTO T 279: Accelerated Polishing of Aggregates Using the British Wheel.
- L. ASTM D 4791: Flat Particles Elongated Particles or Flat and Elongated particles in Coarse Aggregate.
- M. ASTM D 5821: Determining the Percentage of Fractured Particles in Coarse Aggregate.
- N. UDOT 945: Dynamic Stripping Test of Bitumen-Aggregate Mixtures.

## **PART 2 PRODUCTS**

### **2.1 PERFORMANCE GRADED PG BINDER - AASHTO MP 1**

- A. PG58-22 following Section 02745.
- B. PG64-22 following Section 02745.

### **2.2 ANIONIC EMULSIONS**

- A. RS-2 following AASHTO M 140.

### **2.3 CATIONIC EMULSIONS - AASHTO M 208**

- A. CRS-2A following Section 02745.
- B. CRS-2B following Section 02745.
- C. CRS-2P following Section 02745.
- D. LMCRS-2 following Section 02745.

## 2.4 HIGH FLOAT EMULSIONS

- A. HFRS-2P following Section 02745.
- B. HFMS-2 following AASHTO M 140.
- C. HFMS-2P following Section 02745.

## 2.5 FLUSH COAT

- A. Use one of the following emulsions agreed upon by the Engineer, following Section 02745, diluted two parts concentrate to one part water by the Manufacturer:
  - 1. CSS-1
  - 2. CSS-1h
  - 3. SS-1
  - 4. SS-1h
  - 5. HFMS-2P

## 2.6 COVER MATERIAL

- A. Use crusher processed virgin aggregate consisting of natural stone, gravel, or slag meeting the requirements of Table 1.

**Table 1**

Chip Seal Cover Material Properties		
Unit Weight	AASHTO T 19	100 lb/ft <sup>3</sup> , max
One Fractured Face	AASHTO D 5821	95% min.
Two Fractured Faces	AASHTO D 5821	90% min.
LA wear, see Note 1	AASHTO T 96	30% max.
Soundness	AASHTO T 104	10% max.
Flats & Elongates, 1:3 ratio	ASTM D 4791	5% max.
Stripping, see Note 1	Materials MOI 8-945	10% max.
Polishing, see Note 1	AASHTO T 278, T 279	31 min.
Note 1: The Department has the right to waive this requirement if the aggregates have proven acceptable through successful past performance as determined by the Engineer.		

- B. Grade with the following limits to meet the specified test standard in AASHTO T 27 and T 11.

**Table 2**

Sieve Size	Percent Passing		
	Type A	Type B	Type C
1/2 in	100		100
3/8 in	85-100		70-90
No. 4	0-20	100	0-5
No. 8	0-5	85-100	0-3
No. 16		10-25	
No. 50		0-5	
No. 200	0-1	0-2	0-1

## **2.7 BLOTTER MATERIAL**

- A. Refer to Section 02748, article 2.1, B.

## **2.8 TEMPORARY PAVEMENT MARKERS**

- A. Refer to Section 01558.

## **2.9 SOURCE QUALITY ACCEPTANCE- CHIP SEAL COAT ASPHALT EMULSION**

- A. Refer to Minimum Sampling and Testing Requirements Section 02745.
1. Provide a separate oil sampler meeting the requirements of AASHTO T 40 for each delivered truck and trailer not equipped with sampling valves that meet AASHTO T 40. Do not place any chip seal coat emulsion from equipment not meeting this requirement.
  2. Take the samples in the presence of Department personnel using their sample bottles.
  3. Clean and dry the oil sampler after each use following applicable environmental regulations.
  4. Do not place chip seal coat emulsion until the respective viscosity test meets the specification following Section 02745.

## 2.10 SOURCE QUALITY CONTROL - COVER MATERIAL

- A. Department samples at a frequency according to Table 3.

**Table 3**

<b>Stockpiles - Samples and Tests</b>	
<b>Lot Quantity (Ton)</b>	<b>Number of Samples</b>
Lot \$ 2500	5
1500 < Lot < 2500	4
Lot # 1500	3

- B. The Department samples for acceptance either at the source of supply or at the project stockpile. If material previously accepted at the supply source is suspect when delivered to the project, the Department retests following Section 01455, article 1.6 "Samples, Tests, and Referenced Cited Specifications."

**Table 4**

<b>Cover Material (Type A, B, and C)</b>				
<b>Acceptance Schedule For Gradation (Percent passing)</b>				
Sieve Gradation Size	Pay Factor*	Acceptance Band Type A	Acceptance Band Type B	Acceptance Band Type C
	Cover Material	Average of Tests	Average of Tests	Average of Tests
1/2 inch	1.00 0.95 0.90 0.85 Reject	100.0 99.0 98.0 97.0 < 96.9		100.0 99.0 98.0 97.0 <96.9
3/8 inch	1.00 0.95 0.90 0.85 Reject	85.0 - 100 84.0 - 84.9 83.0 - 83.9 82.0 - 82.9 < 81.9		70.0 - 90.0 69.5 - 91.5 69.2 - 92.0 68.0 - 92.0 <67.9 and >92.1
No. 4	1.00 0.95 0.90 0.85 Reject	0 - 20 20.1 - 21 21.1 - 22 22.1 - 23 > 23.1	100.0 99.0 98.0 97.0 < 96.9	0 - 5.0 5.1 - 5.5 5.6 - 6.0 6.1 - 7.0 > 7.1
No. 8	1.00 0.95 0.90 0.85 Reject	0 - 5 5.1 - 5.5 5.6 - 6.0 6.1 - 7.0 > 7.1	85.0 - 100 84.0 - 84.9 83.0 - 83.9 82.0 - 82.9 < 81.9	0.0 - 3.0 3.1 - 3.5 3.6 - 4.0 4.1 - 5.0 > 5.1
No. 16	1.00 0.95 0.90 0.85 Reject		10.0 - 25.0 9.5 - 25.5 9.0 - 26.0 8.5 - 26.5 < 8.4 and > 26.6	
No. 50	1.00 0.95 0.90 0.85 Reject		0.0 - 5.0 5.1 - 5.5 5.6 - 6.0 6.1 - 7.0 > 7.1	
No. 200	1.00 0.75 0.50 Reject	0.0 - 1.0 1.1 - 1.5 1.6 - 2.0 >2.1	0.0 - 2.0 2.1 - 2.5 2.6 - 3.0 > 3.1	0.0 - 1.0 1.1 - 1.5 1.6 - 2.0 >2.1

\* use the lowest individual pay factor for combined gradation

## **PART 3      EXECUTION**

### **3.1      PREPARATION**

- A.      Clean the surface of all dirt, sand, dust, and other objectionable material to the satisfaction of the Engineer.
- B.      Protect all structures from being spattered or marred including guardrail, guide posts, concrete barriers, parapet walls, etc.

### **3.2      LIMITATIONS**

- A.      Complete all work, excluding bituminous flush coat, between May 15 and August 31.
- B.      Do not place any chip seal coat if the Engineer determines that excess moisture is present in the pavement structure.
- C.      Place seal coat when:
  - 1.      Pavement temperature is between 70 degrees F and 136 degrees F.
  - 2.      Air temperature is 70 degrees F and rising in the shade.
- D.      Apply bituminous flush coat material no later than 7 days after the application of the cover material, or as directed by the Engineer.
- E.      Apply bituminous flush coat material when the air temperature in the shade is 50 degrees F and rising.
- F.      Do not apply bituminous flush coat material during fog, rain, or other adverse conditions.
- G.      Complete all chip seal operations, including sweeping during daylight hours.

### **3.3      COVER MATERIAL STOCKPILE**

- A.      Construct on a clean area to minimize contamination.
- B.      Construct to facilitate uniform dampening. Avoid excess moisture.

### **3.4 TEMPORARY PAVEMENT MARKER APPLICATION**

- A. Refer to Section 01558, Temporary Pavement Markings

### **3.5 ASPHALT MATERIAL /COVER MATERIAL APPLICATION**

- A. Use a distributor equipped with a hydrostatic system capable of maintaining a tolerance of " 0.03 gal/yd<sup>2</sup>.
  - 1. Spray the application at a rate sufficient to obtain 60 to 70 percent chip embedment after the completion of rolling operations as determined by the Engineer.
  - 2. Application rates may vary throughout the project depending on existing conditions.
  - 3. Equipment is subject to inspection and approval by the Engineer.
- B. Apply the asphalt emulsion at a minimum temperature of 145 degrees F.
- C. Provide blotter material meeting the requirements of Section 02748 and application equipment approved by the Engineer at the Project location prior to beginning seal coat work.
- D. Place building paper adjacent to the transverse construction joint prior to starting each spraying operation. Maintain the control valve to act instantaneously, both in start-up and cut-off.
- E. Locate longitudinal joints within 6 inches of the traffic lane line location or within 12 inches of the center of a traffic lane. Construct the meet lines with no skips or voids between adjacent passes. Avoid a double thickness of cover material.
- F. Spread the cover material maintaining a tolerance of " 1.0 lb/yd<sup>2</sup>.
  - 1. Equipment is subject to inspection and approval by the Engineer.

- G. Calibrate the spreader at the beginning of each day and as often as required.

**Approximate Spread Rates**

<b>Unit Weight lbs/ft<sup>3</sup></b>	<b>Application Rate lbs/yd<sup>2</sup></b>
60 - 65	17.0
65 - 70	18.4
70 - 75	19.8
75 - 80	20.7
80 - 85	22.1
85 - 90	23.5
90 - 95	24.9
95 - 100	25.8

### **3.6 SURFACE ROLLING**

- A. Use a minimum of two pneumatic-tire rollers in a longitudinal direction to roll surface after the cover material has been spread.
- B. Use a minimum of three passes to seat the cover material.
  - 1. A pass is defined as traveling in one direction only. Two passes is rolling forward and back.
- C. Control bleeding with blotter material and as directed by the Engineer.
- D. Set the roller speed to prevent bouncing or skidding. Reduce roller speeds during directional changes to prevent tearing of the surface. Repair all damage done to the seal coat by the rollers.
- E. Synchronize the speed of the distributor and chip spreader with that of the rolling operation.
- F. Sweep excess cover material off the roadway after the emulsion has set. Remove excess cover material to the satisfaction of the Engineer before opening the roadway to traffic.

### **3.7 BITUMINOUS FLUSH COAT APPLICATION**

- A. Clean the surface of all dirt, sand, dust, loose chips, and other objectionable material to the satisfaction of the Engineer.

- B. Apply the bituminous flush coat at a rate of 0.11 gal/yd<sup>2</sup>. Keep traffic off the flushed surface until the bituminous material has set sufficiently to prevent tracking or pick-up.
- C. Provide vendor's bill of lading certifying the material was diluted in accordance with paragraph A of article 2.5, "Flush Coat." The Department may sample and test this material for specification compliance.

### **3.8 TRAFFIC CONTROL**

- A. Refer to Section 01554.

END OF SECTION

**Change One - August 29, 2002**

**No changes made**

**Change Two - December 19, 2002**

**Articles Revised**

**3.2 C 2**

**Change Three – February 27, 2003**

**Articles Revised**

**1.2 C and D added**

## **SECTION 02892**

# **TRAFFIC SIGNAL**

### **PART 1 GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Materials and procedures for installing traffic signals.
- B. Materials and procedures for installing traffic counting loop detectors.

#### **1.2 RELATED SECTIONS**

- A. Section 02741: Hot Mix Asphalt (HMA)
- B. Section 02748: Prime Coat/Tack Coat
- C. Section 03055: Portland Cement Concrete
- D. Section 03211: Reinforcing Steel and Welded Wire
- E. Section 03310: Structural Concrete
- F. Section 03575: Flowable Fill
- G. Section 16135: Electrical Junction Boxes
- H. Section 16525: Highway Lighting

#### **1.3 REFERENCES**

- A. AASHTO M 111: Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- B. AISI, Type 201
- C. ANSI/UL 467
- D. ASTM A 123: Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

- E. ASTM A 325: Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
- F. ASTM A 307: Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
- G. ASTM A 570: Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
- H. ASTM B 85: Aluminum-Alloy Die Castings
- I. ASTM B 117: Operating Salt Spray (Fog) Apparatus
- J. ASTM B 766: Electrodeposited Coatings of Cadmium
- K. ASTM D 638: Tensile Properties of Plastic
- L. ASTM D 2240: Rubber Property-Durometer Hardness
- M. ASTM D 3005: Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
- N. Electronics Industries Association (EIA)
- O. International Municipal Signal Association (IMSA): 20-1, 50-2, 51-1, 51-3, 51-5, 51-7, 60-6
- P. Institute of Electrical and Electronics Engineers (IEEE)
- Q. Institute of Traffic Engineers (ITE), Technical Report No. 1, and 4
- R. Military Spec. Mil-C-5541, and TTE-529
- S. NEC 250-1: National Electric Code
- T. NEMA Listed
- U. REA (Rural Electrical Association) Bulletin 17551-100
- V. UL 6
- W. UL 510
- X. UL E-50076
- Y. VTC SH

## 1.4 SUBMITTALS

- A. Certified test report of wire compliance as specified. IMSA 20-1, 50-2, 51-1, 51-3, 51-5, 51-7, 60-6.
- B. Submit samples of materials for approval when requested.
- C. Submit two copies of the following within 15 days after receiving a Notice to Proceed:
  - 1. List of equipment and materials (name of manufacturer, size, and identification number).
  - 2. Detailed shop drawing, wiring diagrams, and certifications.
  - 3. Manufacturers' warranties, guarantees, instruction sheets, and parts lists.

## 1.5 ACCEPTANCE

- A. Signal Warranties and Guarantees
  - 1. The notice of acceptance for traffic signal work is not given until six months after the date of the inspection.
  - 2. During this period, all manufacturer's warranties and guarantees on Contractor- furnished electrical and mechanical equipment are enforced.
  - 3. At the end of the period and after all electrical and mechanical defects within the scope of warranties and guarantees are corrected, the Engineer makes written acceptance of the work completed and relieves the Contractor of further responsibility for that portion of the project.
  - 4. Partial acceptance does not void or alter any terms of the Contract
- B. The six-month warranty period for signal work does not affect the processing of a semi- final estimate when the Contract is 95 percent or more complete, or after completion of work on the project.
- C. Detector Loop Circuit: Conduct the following acceptance tests before and after backfill for approval by the Engineer.
  - 1. Loop Resistance Formula:  $R_t = R_l + R_d$ 
    - $R_t$  = Resistance of loop as measured at pull box.
    - $R_l$  = Resistance of loop lead in wire (from the loop to junction box per meter) equals 0.0213 ohms, measured from loop to pull box splice.
    - $R_d$  = Resistance of Loop =  $P.T.R_c$  (See Loop Resistance Table below)

$P$  = Perimeter of loop in meters.

T= Number of turns in the loop.  
R<sub>c</sub>= Resistance of #14 AWG copper wire per yard equals 0.0107 ohms.

**Table 1**

<b>Loop Resistance</b>			
<b>Loop Type</b>			<b>R<sub>d</sub> Loop Resistance (ohms)</b>
<b>Width (ft)</b>	<b>Length (ft)</b>	<b>Turns</b>	
5	6	4	.29
5	10	4	.39
6	6	4	.31
6	10	4	.41
6	12	4	.47
6	14	3	.39
6	16	3	.43

2. A minimum reading between the conductor and ground of 100 MΩ when tested with a 500 V megger meter.
3. An inductance between 65 FH and 1000 FH.
4. Signal Power Circuits:
  - a. Continuity of grounding conductors to maintain a 1000 W load at each pole to maintain less than 2 V drop.
  - b. Insulations resistance of supply conductors to ground no less than 40 MΩ (500 V megger meter).

D. Video Detection Circuit: Provide cabling and install State-furnished video detection equipment to construct a complete video detection circuit at each intersection specified in the project and demonstrate each circuit operates per manufacturer's specifications.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- A. Use electrical components as listed and defined by the National Electric Code (NEC).

## **2.2 SIGNAL POLE AND TRAFFIC SIGNAL LIGHT SUPPORT ARM**

- A. Post mounted Tapered Signals Pole: Standard Drawing SL 5.
  - 1. Steel, as specified. ASTM A 570, Grade 33.  
Allowable stresses:  $F_b = 21,750 \text{ psi } (0.66F_y)$   
 $F_v = 10,900 \text{ psi } (0.33 F_y)$
  - 2. Galvanized as specified. AASHTO M 111.
  - 3. Wind load: 80 mph wind with 105 mph gusts.
- B. Foundation:
  - 1. Concrete: Class AA(AE) Concrete. Refer to Section 03055.
  - 2. Reinforcing steel: Coated steel. Refer to Section 03211.

## **2.3 BOLTS AND NUTS**

- A. Anchor bolts and nuts: Follow Standard Drawing SL 5.
  - 1. Steel as specified. ASTM A 307.
  - 2. Zinc-plated or galvanized, as specified.
    - a. Zinc-plated as specified. ASTM B 766.
    - b. Galvanized steel: ASTM A 123.
  - 3. Nuts: free running, by hand, for total thread length.
- B. Slip Bolts as specified.
  - 1. Zinc plated: ASTM B 766.
  - 2. Steel: ASTM A 325.

## **2.4 WIRE**

- A. Copper, as specified. International Municipal Signal Association (IMSA).
- B. Size as specified. American Wire Gauge (AWG).
- C. Service Cable:
  - 1. Single-conductor, as specified. Type THWN, THW, THHW.
- D. Interconnect cable:
  - 1. Twisted pair filled shielded cable, as specified.
  - 2. IMSA 60-6.
- E. Signal Cable:
  - 1. Multi-colored cables, as specified.
  - 2. IMSA 20-1

- F. Ground Wire:
  - 1. Solid, bare, soft-drawn, copper wire, as specified.
  - 2. NEC 250-1.
- G. Splice Sealing: Rural Electrical Association (REA) Bulletin 17551-100.
  - 1. Rigid body re-enterable gel-filled enclosure. Meet 3M-8982/gel, or equivalent.
  - 2. Mastic rubber pads and overwrap with vinyl electric tape.
  - 3. ASTM D 3005, Type I or II. UL 510.
- H. Color Coding Tape:
  - 1. Vinyl electric tape, as specified.
  - 2. UL 510.
- I. Video Detection Circuit:
  - 1. Camera circuit cable - Belden 8281 or equivalent, coaxial cable, RG 59/U Type 20 AWG.
  - 2. Camera power circuit - 4-conductor, 14AWG SJOW cable, IMSA specification 20-1.

## **2.5 TRAFFIC SIGNAL HEAD**

- A. Use Standard Drawing SL 8.
- B. 12 inch vehicular signal heads:
  - 1. With tunnel hoods and mounting brackets, square doors,
  - 2. Capable of adjusting a full 360 degrees around a vertical axis in one direction.
- C. Assembly:
  - 1. LED Ball and Arrow Vehicle Signal Modules:
    - a. Modules fit into existing housing built to the VTCSH standard without modification to the modules or housing.
    - b. Arrow modules have at least three rows of LEDs. Balls must be full field design. Both ball and arrow modules must be capable of installation in signal head with reflector in place.
    - c. Ensure the measured chromaticity coordinates of modules is between 500 nm and 650 nm, conforming to the chromaticity requirements of the VTCSH standard.
  - 2. Sections Heads:
    - a. Separate, interchangeable, and expandable without tie rods.
    - b. Stainless steel bolts, screws hinge pins, and door-locking devices in any exposed sections.

- c. Die-cast aluminum parts, including the doors, as specified: ASTM B 85. Clean, smooth parts free from flaws, cracks, blow holes, or other imperfections.
- d. Moisture and dust resistant.
- e. All surfaces inside and out of signal housing, door, and outside of visor are painted with electrostatically-applied, fused-polyester paint in Highway Yellow. Inside of visor is painted flat black.
- f. Integrally round serrated boss openings in the top and bottom of each section that receives 1.5-inch supporting pipe frame.
- g. Rain-tight top opening and an ornamental cap for closing the bottom opening.
- h. Visor securely mounted at a minimum of four points.

D. Optical Unit:

- 1. Watertight and dust resistant, mounted so various parts swing open for easy access. Provide and install green, amber, and red LED modules. Install each LED signal module in the door frame of a standard traffic signal head housing. Remove the lamp socket, reflector, reflector holder, and lens used with an incandescent lamp. Do not use with the LED signal module. Remove socket, reflector, reflector holder, and lens and wire the LED module to the traffic signal heads.

E. Louvered back plate

- 1. Constructed from minimum 18-gage aluminum.
- 2. Both sides primed and painted flat black.
- 3. Designed to be attached to the signal head used.

## 2.6 PEDESTRIAN SIGNAL HEAD

A. Follow Standard Drawing SL 9.

B. Includes a housing, swing down door assembly, parabolic reflector, message lens, sunshield, two signal lamps and two sockets.

- 1. Housing:
  - a. Dustproof and weatherproof.
  - b. Die cast, single piece aluminum alloy.
  - c. 1-1/2 inch top and bottom openings with integrally-cast shurlock boss when used with pipe mount brackets.
  - d. Use stainless steel screws springs, and assembly hardware.
- 2. Swing down door assembly:
  - a. Capable of being opened without tools.
  - b. Made of a single piece aluminum alloy, die cast with two hinge lugs at the bottom and two latch slots at the top of the door.

3. Install each LED pedestrian head in the door frame of a standard pedestrian head housing. The lamp socket, reflector, reflector holder, and lens used with an incandescent lamp must be removed and not used with the LED pedestrian modules. Remove lamp socket, reflector, reflector holder, and lens and wire the LED module to the pedestrian heads.
4. Sunshield:
  - a. Eggcrate-type with 15 vertical and 26 horizontal members.
  - b. Two anti-vandal, integral locking strips.
  - c. Minimum thickness of 20-gage.
  - d. Finish: 100 percent impregnated black, polycarbonate plastic, with a flat finish on both sides.
5. Electrostatically apply synthetic enamel as specified.
  - a. Gloss black case and door frame.
  - b. Flat black sunshield.
  - c. Oven-cure finish for a minimum of 20 minutes at 350° F.
6. Pedestrian Display Signal Module
  - a. Use LED Pedestrian Signal Modules that are a retrofit replacement for the message bearing surface of a 16 inch x 18 inch pedestrian traffic signal housing built to the Pedestrian Traffic Control Signal Indicator (PTCSI) Standard. The message-bearing surface of the module shall be supplied with “HAND” and “MAN” symbol that complies with PTCSI standard for this symbol. This message-bearing surface is designed so that it can be removed from the sealed unit for replacement without further damage to the module.
  - b. Ensure the exterior of the lens of the LED Pedestrian Signal Module is smooth and frosted to prevent sun phantom.
  - c. Ensure all Portland Orange LEDs utilize “AllInGap” technology or equivalent, and rated for 100,000 hours or more at 77° F and 20 mA.
  - d. Ensure the LED Pedestrian Signal Module is designed so that when operated over the specified ambient temperature and voltage range, the signal will attract the attention of, and be readable to a viewer (both day and night) at all distances from 10 ft. to full width of the area to be crossed. Use a minimum of 150 LEDs in the Portland orange hand symbol and 100 LEDs in the white man symbol.
  - e. Ensure the measured chromaticity coordinates of the LED Pedestrian Signal Module conforms to the chromaticity requirements of the PTCSI Standard.
  - f. Ensure the LED pedestrian signal module is operationally compatible with the currently used controller assemblies and conflict monitors.

- C. Ensure symbol messages blank out under ambient light conditions when the pedestrian signal is not energized.

## **2.7 ELECTRICAL CONDUIT**

- A. Conduit and fittings:
  - 1. Schedule 40 PVC rated at 190 degrees F. as specified. NEMA TC-2, TC-3. UL Listed.
  - 2. Rigid steel as specified. UL 6.
  - 3. Galvanized as specified. ANSI C80.1.
- B. Casing: Smooth steel with a minimum 1/4 inch wall thickness as specified.

## **2.8 DETECTOR CIRCUIT**

- A. Wire:
  - 1. Detector Lead-In Wire (feeder): as specified. IMSA 50-2.
  - 2. PVC Sensor Loop Wire - No. 14, single-conductor, stranded wire as specified. IMSA 51-3.
  - 3. Saw Cut Sensor Loop Wire.
  - 4. No. 14, single-conductor, stranded wire encased in a polyethylene tube as specified. IMSA 51-7.
- B. Traffic loop embedding sealant:
  - 1. Isophthalic, acid-based, unsaturated, polyester resin.
  - 2. With sufficient adhesion, strength, and flexibility to:
    - a. Withstand normal movement in asphaltic and concrete pavements
    - b. Protect the loop wire from moisture penetration, fracture and shear.
  - 3. Cured sealant resistant to motor oils, gasoline, anti-freeze solution, brake fluid, and de-icing chemicals.
  - 4. Meet the physical property requirements in Table 2.

**Table 2**

<b>Traffic Loop Embedding Sealant</b>		
<b>Physical Properties</b>	<b>Test</b>	
Shore D Hardness	ASTM D 2240	74
Specific Gravity		1.13 - 1.20
Styrene Monomer, percent		28 - 32
Viscosity: Pa·s	Brookfield Model LVF #3 Spindle @ 60 rpm	0.7-0.9
Gel Time	MEK Peroxide 46-709	11 - 15 minutes
Tensile Elongation, % @ Break	ASTM D 638	50
Pot life, minimum		5 minutes
Tensile Strength	ASTM D 638	2,000 psi

## 2.9 LUMINAIRE

- A. Housing:
  - 1. Die-cast aluminum
  - 2. Reflectors, sockets, mounting cradles, and clamps fitted to the upper housing.
- B. Integral ballast: Pre-wired with quick disconnect plugs mounted on a removable, hinged power door.
- C. Power Door: Ballast assembly interchangeable with all luminaires, regardless of wattage.
- D. Optical assembly: Formed aluminum reflectors with a chemically bonded, non-breakable, glass finish on both the inside and outside surfaces.
- E. Mogul base sockets:
  - 1. Adjustable with split-shell, tempered-brass lamp grips.
  - 2. Free-floating, spring loaded center contacts.
  - 3. Heat- and impact-resistant glass prismatic refractors.
- F. Mounting adjustment:
  - 1. 10 degrees above horizontal for the reflector and refractor.
  - 2. 5 degrees adjustment from vertical on the bracket arm.
- G. Weight: no more than 75 lbs.

- H. Projected area: no more than 3 square feet.
- I. Ballast: high pressure sodium type that will:
  - 1. Maintain a minimum power factor of 90 percent.
  - 2. Maintain lamp wattage of not more than 5 percent for nominal line and lamp voltage.
  - 3. Maintain regulation of not more than 35 percent for a 10 percent line voltage variation.
  - 4. Start and operate the lamp at ambient temperatures down to -40 degrees F.
  - 5. Sustain lamp operation for a minimum of 4 seconds at a voltage dip of 35 percent.
- J. Lamp: high pressure sodium lamp that uses clear bulbs and has:
  - 1. Apparent color temperature of 2100 K.
  - 2. CIE chromaticity of  $X = 0.512$ ,  $Y = 0.420$ .
  - 3. Rated-life of not less than 24 000 hours per 10 hour start.

## **2.10 GROUND ROD**

- A. Copper-coated steel as specified.
- B. ANSI/UL 467.

## **2.11 MESSENGER**

- A. 3/8 inch diameter galvanized, stranded steel cable.
- B. Minimum breaking strength of 10,800 lbs, as specified.
- C. ASTM A 123.

## **2.12 MOUNTING BANDS AND BUCKLES**

- A. As specified.
- B. American Iron and Steel Institute, (AISI) Type 201.

## **2.13 POWER SOURCE**

- A. Pole Mount: Standard Drawing SL 6.
  - 1. Service disconnect:
    - a. Single pole 40 amp 120 volt AC metered for signal.
    - b. Double pole 20 amp 240 volt un-metered for lighting.

2. Provide a manual EUSERC approved circuit closing link by-pass release meter socket.
  3. Unmetered street lighting circuit.
- B. Underground Service Pedestal: As specified. ASTM B 117, and ASTM A 123 (Cabinet). UL E 50076
1. Enclosure: 0.120 inch galvanized steel or anodized aluminum.
    - a. 0.080 inch galvanized steel or anodized aluminum covers.
    - b. Finished surface with an environmental green, baked enamel over zinc-chromate primer as specified, or anodized aluminum. ASTM B 117.
    - c. Bottom access opening.
    - d. Electrical Utility Service Equipment Requirements Committee (EUSERC) approved circuit-closing by-pass release meter socket.
    - e. Baffled ventilation louvers.
- C. Circuit Breaker: Main Breaker
1. Six space metered.
  2. Six space unmetered bus.
- D. Detachable, pad-mount base.

## **2.14 FLOWABLE FILL**

- A. Refer to Section 03575.

## **2.15 HOT MIX ASPHALT**

- A. 1/2 inch maximum. Refer to Section 02741.

## **2.16 LED TRAFFIC SIGNAL HEAD MODULE**

- A. Regulations and Codes. Use new modules that conform to the applicable requirements of the Underwriters Laboratory Incorporated (UL), the Institute of Electrical and Electronics Engineers (IEEE), the Electronics Industries Association (EIA), the National Electronic Code (NEC), the American Society of Testing and Materials (ATMS), the American National Standards Institute (ANSI), and the applicable standards, specifications, and regulations of the UDOT.
- B. Ensure certification to NEMA, ITE and VTCSH Standards. Ensure LED TSMs meet current applicable NEMA standards. Bidders are required to supply a certified letter from an independent testing laboratory stating the module(s) has been tested and meets NEMA environmental standards and test procedures.

C. Physical and Mechanical Requirements

1. Retrofit Requirements

- a. Use retrofit module replacements for existing signal lamps that do not require special tools for installation. Use modules that fit into existing traffic signal housing without modification to the housing.
  - b. Use retrofit replacement modules that only require removal of the existing optical unit components, i.e., lens, lamp module, gaskets, and reflector. The module is weather tight and fits securely in the housing, and connects directly to existing electrical wiring. Screw-in modules are not acceptable.
  - c. Use retrofit module that includes all necessary components to complete the conversion, including a one-piece gasket.
2. Optical Unit - Use modules capable of replacing the optical unit.
  3. Tinting - Use tinted lens or transparent film or materials with similar characteristics.
  4. Lens - Use module lens that is a field replaceable part without the need to replace the complete module.

D. Environmental Requirements

1. Use modules rated for use in the ambient operating temperature range, measured at the exposed rear of the module, of -40 degrees F to +165 degrees F. Use modules that incorporate temperature compensated LED technology to operate in the above mentioned temperature ranges.
2. Use modules protected against dust and moisture intrusion per the requirements of NEMA Standard 250-1991, sections 4.7.2.1 and 4.7.3.2, for Type 4 enclosures to protect all internal LED, electronic, and electrical components.
3. Use polycarbonate module lens that is UV stabilized and is a minimum of 1/4 inch thick.

E. Construction

1. Use modules that are a single, self-contained device, not requiring on-site assembly for installation into an existing traffic signal housing, with the power supply integrated into the module.
2. Use modules that have an assembly and manufacturing process designed to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.
3. Use modules that are repairable by a bench technician.

- F. Materials
  - 1. Use materials for the lens and signal modules construction that conform to ASTM specifications for the materials where applicable.
  - 2. Use enclosures containing either the power supply or electronic components of the signal module constructed of UL94VO flame retardant materials. The signal module lenses are excluded from this requirement.
- G. Module Identification - Identify each individual module for warranty purposes.
  - 1. Identify each module on the backside with the manufacturer's name and serial numbers.
  - 2. Identify the following operating characteristics: nominal operating voltage, power consumption, and Volt-Ampere.
  - 3. Use modules that have a prominent and permanent vertical indexing indicator, i.e., UP ARROW or the word UP or TOP, for correct indexing and orientation inside a signal housing.
  - 4. Use modules conforming to this specification that have the following statement: "Manufactured in Conformance with the Interim Purchase Specification of the ITE for LED Vehicle Traffic Signal Modules" on an attached label.
- H. Photometric Requirements
  - 1. Luminous Intensity And Distribution
    - a. Ensure the maintained minimum luminous intensity values for modules throughout the warranty period, under the operating conditions defined in Articles D and I-2a, and at the end of the warranty period, are not be less than the values shown in Table 3.

**Table 3**

<b>Maintained Minimum Luminous Intensity for LED Signal Modules Candlepower Values (candelas [cd])</b>				
Vertical Angle Down	Horizontal Angle Left & Right	Red (12-inch)	Yellow (12-inch)	Green (12-inch)
(degrees)	(degrees)	(cd)	(cd)	(cd)
2.5	2.5	339	1571	678
	7.5	251	1159	501
	12.5	141	655	283
	17.5	77	355	154
7.5	2.5	226	1047	452
	7.5	202	935	404
	12.5	145	673	291
	17.5	89	411	178
	22.5	38	178	77
	27.5	16	75	32
12.5	2.5	50	234	101
	7.5	48	224	97
	12.5	44	206	89
	17.5	34	159	69
	22.5	22	103	44
	27.5	16	75	32
17.5	2.5	22	103	44
	7.5	22	103	44
	12.5	22	103	44
	17.5	22	103	44
	22.5	20	94	41
	27.5	16	75	32

- b. Ensure the maximum luminous intensity for 12-inch signals do not exceed 800 candelas for the Red, 1,600 candelas for the Green, 3,700 candelas for the Yellow when operating within the temperature specified in Articles D-1 during the warranty period.
2. Color and Brightness - Use modules that meet all ITE color and brightness specifications.
3. Photometric Maintenance - Ensure the manufacturer has a process to test compliance of minimum intensity values in a controlled and independent laboratory during anytime in the warranty period. Alternately, ensure the manufacturer has available a portable, calibrated light meter to allow for field measurement of luminous intensity of Modules.

I. Electrical Requirements

1. General - Ensure all wiring and terminal blocks meet the requirements of Section 13.02 of the VTCSH standard. Two secured, color coded, 36-inch long, 600V, 16 AWG minimum, insulated wires, conforming to the NEC, rated for service at 220 degrees F, and spaded lugs, are provided for electrical connection.
2. Voltage Range.
  - a. Ensure modules operate from a  $60\pm3$  cycle ac line power over a voltage range from 80V rms to 135V rms. The current draw shall be sufficient to ensure compatibility and proper triggering and operation of load current switches and conflict monitors in the signal controller units the Department has in use.
  - b. Ensure nominal operating voltage for all measurements is  $120\pm3$  volts rms.
  - c. Ensure fluctuations in voltage over the range of 80V rms to 135V rms do not affect luminous intensity by more than  $\pm 10$  percent.
  - d. Ensure the LED circuitry prevents flicker at less than 100 Hz over the voltage specified in Articles I-2a.
3. Transient Voltage Protection - Ensure module on-board circuitry includes voltage surge protection to withstand high-repetition noise transients and low-repetition, high-energy transients as stated in Section 2.1.6, NEMA Standard TS-2, 1992
4. LED Drive Circuitry - Ensure individual LED light sources are wired so that a catastrophic failure of one LED light source will result in the loss of not more than 20 percent of the signal module light output.
5. Electronic Noise - Ensure the LED signal and associated onboard circuitry meets Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
6. Power Factor (Pf) and AC Harmonics:
  - a. Ensure modules provide a power factor of 0.90 or greater when operated at nominal operating voltage, and 77 degrees F.
  - b. Ensure total harmonic distortion induced into an ac power line by a Module, operated at nominal operating voltage, with power consumption equal to or greater than 15 watts at 77 degrees F does not exceed 20 percent.
  - c. Ensure total harmonic distortion induced into an ac power line by a Module, operated at nominal operating voltage, with a power consumption equal to or less than 15 watts at 77 degrees F does not exceed 40 percent.
7. Failed State Impedance – Ensure modules are designed to sense a loss of light output due to catastrophic LED failures of between 25 to 40 percent. Loss of light output due to LED failure is not detected of losses of less than 25 percent but is detected for any loss of light greater than 40 percent. Ensure the unit, upon sensing a valid loss of light, presents an impedance of 500 K ohms to the ac line.

8. Electronics Technology – Ensure modules use the latest 0.20-inch (5 mm) electronics technology.
- J. Manufacturers Certification of Compliance and Warranty Provisions:
  1. Certificate of Compliance – Ensure manufacturers provide a Certificate of Compliance to this specification for each shipment of Modules. Identify each Module per Section G.
  2. Warranty Provisions - Ensure Bidder provides the following minimum warranty provisions:
    - a. Replace or repair module if it fails to function as intended due to workmanship or material defects within the first 84 months from the date of delivery. If repaired, the warranty covers all parts and labor necessary or incidental to the repair.
    - b. Ensure the period of guarantee coverage, in no case, is less than the manufacturers usual and customary guarantee period. Provide all guarantees that are customarily issued by the Bidder and/or manufacturer to the State of Utah.
    - c. The Bidder may elect to have UDOT make minor repairs or their appointee, with the consent of the manufacturer. Make all other repairs under warranty by the manufacturer. The manufacturer bears all costs including labor, parts, and shipping charges.
    - d. Replace or repair all LED Vehicle Traffic Signal Modules that exhibit luminous intensities less than the minimum values specified in Article H-1a within the first 60 months of the date of delivery.

## **2.17 VIDEO DETECTION CIRCUIT**

- A. Provide conduit, cabling and lighting, and install State-Furnished video detection equipment as shown in the plans to construct a complete and operational video detection circuit at each intersection.
- B. Provide all additional mounting brackets, termination boxes, and other equipment, material and labor necessary to construct a complete and operational video detection circuit per manufacturer recommendations.

## **PART 3 EXECUTION**

### **3.1 PREPARATION**

- A. Conform to the National Electrical Code (NEC).
- B. Pick up State-furnished materials at the Department's Central Warehouse, 4501 South 2700 West, Salt Lake City, UT.

- C. Saw cut concrete or other improved surfaces to be removed in the sidewalk area, and replace with in-kind materials to match the existing grade.
- D. Attach brackets with a banding machine with stainless steel bands. Do not drill holes in poles except as shown on the plans. Follow Standard Drawings SL 9 and SL 2.
- E. Do not disconnect or remove an existing signal system until the replacement system is functioning.
- F. Contact power company at least 30 days before the connection date, and verify the exact location, voltage, procedure, and materials required by the power company.

### **3.2 CONSTRUCT POLE FOUNDATION**

- A. Follow Standard Drawings SL 4 and SL 10.
- B. Concrete: AA(AE) required. Refer to Section 03055.
- C. Structural Concrete: Refer to Section 03310.
- D. Reinforcing Steel and Welded Wire: Refer to Section 03211.
- E. Do not weld reinforcing steel, anchor bolts, or conduit.
  - 1. Use tie wire to secure conduit.
  - 2. Use template to align and secure anchor bolts.
- F. Place the concrete directly into the excavation, and use minimum forming above ground.

### **3.3 TRENCH FOR CONDUIT**

- A. Paved Surface (asphalt concrete):
  - 1. Do not use backhoe.
  - 2. Make the trench 6 inches wide or less.
  - 3. Use flowable fill to within 3 inches of the existing roadway surface.
  - 4. Evenly apply tack coat before final backfill.
  - 5. Match the composition, density, and elevation (" 3/16 inch) of the existing surface in the final 3 inches of backfill.
- B. Unpaved Surface:

1. Use backfill that matches the composition, density, and elevation (" 3/16 inch) of the existing surface.
  2. Install conduits that cross finished curbs and gutters, sidewalks, concrete flatwork, textured or decorative surfaces by jacking, drilling, or pushing. Entirely replace any damaged section at no additional cost to Department.
  3. Dispose of surplus material daily.
- C. Trenching under Railroad (Subject to agreement with railroad):
1. Install smooth steel casing a minimum depth of 4 ft under railroad track to house conduit.
  2. 6 inch diameter casing with a minimum 7/32 inch wall thickness, and a minimum yield strength of 34,950 psi.
- D. Minimum cover of conduit:
1. Minimum cover for all roadway crossings: 2 ft.
  2. Minimum cover off roadway without concrete encasement or capping: 18 inches.
  3. Minimum cover off roadway with concrete encasement or capping with minimum thickness of 2 inches: 12 inches.

### **3.4 INSTALL CONDUIT**

- A. Place all conduits in the same trench before surfacing.
- B. Above ground use galvanized rigid steel; under ground use PVC.
- C. Seal uncapped conduit ends inside junction box with at least 2 inches of duct caulking.
- D. In future-use conduit, install No. 14 single conductor copper, type THHN pull wire.
1. On each end of conduit install cap with 7/32 inch hole for pull wire.
  2. Leave 20 inches of wire outside of the cap, fastened securely.
  3. Place future-use conduit in top portion of trench for easier access later.
- E. Secure conduit on structures with standard galvanized iron conduit clamps using at least 5/16 inch diameter concrete expansion anchors at maximum 5 ft spacing.
- F. Use conduit expansion fittings at structure expansion joint crossings.

### 3.5 INSTALL WIRING

- A. Conductors:
  - 1. Clean and dry the inside of the conduit before installing conductors.
  - 2. Install grounding conductor in all power circuit conduits.
  - 3. Use powdered soapstone, talc or other approved lubricants when pulling conductors in conduit.
  - 4. Tape the ends of unused conductors and label them as spares.
  - 5. Use conductors that are color coded as specified. Meet IMSA 20-1.
- B. Ground wire:
  - 1. In all non-metallic conduit, a ground wire must run continuously and be grounded at each junction box, except in those conduits used solely for interconnect and detector circuits.
  - 2. Bond the ground wire to the ground rod in each junction box except in circuits with less than 50 V.
- C. Neatly arrange wiring within cabinets, junction boxes, fixtures, etc.
- D. Terminate all terminal connections by a mechanical (spade) connector.
- E. Wire splicing:
  - 1. Splice wires only in detection circuits where the wire type changes in the junction boxes.
  - 2. Mechanically secure or solder, individually insulate, and water seal all splices. Encapsulate in a rigid body re-enterable gel filled enclosure, or cover with mastic rubber pads and overwrap with vinyl electric tape.
- F. Mark cabinet cables with vinyl electrical color coding tape as specified according to Table 4. Meet UL 510.

**Table 4**

<b>Cables Marked with Colored Tape</b>				
	<b>Northbound P2</b>	<b>Southbound P3</b>	<b>Eastbound P4</b>	<b>Westbound P1</b>
<b>Signal Circuit</b>	Blue	Red	Yellow	Orange
<b>Detector Circuit</b>	Blue	Red	Yellow	Orange
	<b>Circuit Coding</b> One band, Through, 2 bands, Left Turn, 3 bands, "Q's", Four bands, Dilemma			
<b>Pedestrian</b>	Blue & Green	Red & Green	Yellow & Green	Orange & Green
<b>Pedestrian Button Circuit (3)</b>	Blue & White	Red & White	Yellow & White	Orange & White

G. Connect conductors according to Table 5.

**Table 5**

<b>Color-Coded Conductors</b>		
	<b>North-South</b>	<b>East-West</b>
<b>Seven-Conductor Pedestrian Circuit</b>	Red - Don't Walk Green - Walk White – Neutral	Black - Spare Orange - Don't Walk Blue - Walk White with Black Tracer - Neutral
<b>Three-Conductor Pedestrian Head Circuit</b>	Red - Pedestrian Call White - Common	Black - Pedestrian Call White - Common
<b>Seven-Conductor Signal Circuit</b>	White - Neutral Red - Red Through Orange - Yellow Through Green - Green Through Blue - Green Arrow White with Black Tracer - Yellow Left Black - Left red or spare	

### **3.6 INSTALL DETECTOR LOOPS**

- A. Follow Standard Drawings SL 11 and SL 13.
- B. One turn is once around the perimeter of the loop with the same conductor.
  - 1. Use number of turns as specified in Table 1 (Loop Resistance Table).
  - 2. Do not allow twists in the loop.
- C. Loop lead-in from loop to junction box:
  - 1. Minimum of 3 twists per yard in saw cut.
  - 2. Minimum of 10 twists per yard for conduit.
  - 3. Do not interweave with other loop lead-ins.
  - 4. Each lead-in requires a separate conduit.
- D. For Detector Lead-in (feeder) from the junction box to controller cabinet, carry shield across all splices.
- E. Saw cut loop:
  - 1. Round the corners with a minimum of 2 inch drill.
  - 2. Remove all loose material and wash and dry all saw cuts.
  - 3. Place all loop wire in a 1/4 inch polyethylene tube.
  - 4. Seat the conductor with no damage at the bottom of the slot.
  - 5. Fill the saw cut with embedding sealant, surround the polyethylene tube to the level of the existing roadway surface " 1/4 inch. Remove any excess embedding sealant.
- F. PVC loop:
  - 1. Trench 2 inch maximum width with 4 inch minimum to 6 inch maximum cover.
  - 2. Anchor sensor loops to prevent movement or floating.
  - 3. Apply a tack coat to the sides and the bottom of the remaining 3 inches of trench and backfill with hot mix asphalt. Refer to Sections 02741 and 02748.
  - 4. Loops in new pavement preformed and placed 1 3/4 inches below the surface of the base course and backfill with surrounding material.

### **3.7 INSTALL POWER SOURCE**

- A. Verify the exact location, voltage, procedure, and materials required by the power company.
- B. Follow Standard Drawing SL 6.

### **3.8 INSTALL LUMINAIRE**

- A. As specified.
- B. Follow Standard Drawing SL 1.

### **3.9 INSTALL SIGNAL HEAD**

- A. Do not install signal heads at the intersection until ready for operation.
- B. If turn on is not immediate, completely cover the signal heads with non-transparent, non-paper material tied securely around head.
- C. Install directed and veiled optically-programmed signals following the manufacturer's instructions. Mask each section of the signal with prescribed materials.
- D. Use louvered back plates on all signal heads except Type V and VI. Use a minimum of four 1/8 inch stainless steel screws per section to mount the back plates, or according to manufacturer's instructions.

### **3.10 REMOVE AND SALVAGE EXISTING EQUIPMENT**

- A. Light poles, signal poles, messenger cable, signal and pedestrian heads, controller cabinets, other items as specified on the plans remain the property of the Department.
- B. Transport items to the specified location.
- C. Remove foundations to a depth of at least 6 inches below the existing surface.
- D. Backfill all holes with local material and compact to the density of the surrounding area.

### **3.11 INSTALL VIDEO DETECTION**

- A. Install all video detection components in accordance with the manufacturer specifications.
- B. Mount each video detection camera on the signal mast arm using the State-Furnished 46-inch extension pole and mounting bracket.
- C. Aim and set camera position and program detection areas as directed by the Engineer.

END OF SECTION

**Change One – August 29, 2002**

**Revised Articles**

**1.5 A, B (Added)**

**Change Two – December 19, 2002**

**No changes made**

**Change Three – February 27, 2003**

**Added Articles**

**1.3 N, O, Y**

**1.5 D**

**2.4 I**

**2.5 C, D, E**

**2.6 B3 - B6**

**2.6 C**

**2.16**

**2.17**

**3.11**

**Revised Articles**

**3.5 F and Table Number**

**3.5 G and Table Number**

## **SECTION 02896**

# **BOUNDARY SURVEY**

### **PART 1 GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Provide boundary survey, and plat.
- B. Furnish and set right-of-way markers.

#### **1.2 RELATED SECTIONS**

- A. Section 03055: Portland Cement Concrete.

#### **1.3 REFERENCES**

- A. ASTM A 53: Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

### **PART 2 PRODUCTS**

#### **2.1 RIGHT-OF-WAY MARKERS**

- A. Pipe: As shown in Standard Drawing GW 6. Meet ASTM A 53, Schedule 40, Galvanized.
- B. Cast bronze cap: Free from defects and constructed as shown in Standard Drawing GW 6.

#### **2.2 CONCRETE**

- A. Class B concrete per Section 03055.
- B. May substitute higher class of concrete.

## **PART 3      EXECUTION**

### **3.1      RIGHT-OF-WAY MARKERS**

- A.    Place Right-of-Way Markers in accordance with Standard Drawing GW 6, including stamping onto each Right-of-Way Marker:
  - 1.      Control Line station.
  - 2.      Elevation. (To 2 decimal places)
  - 3.      Professional Land Surveyor's License Number.
  - 4.      Year.
- B.    Tightly rivet cap to the pipe.

### **3.2      BOUNDARY SURVEY**

- A.    Provide record of survey plat by Utah licensed surveyor.
- B.    File mylar copy of plat with county surveyor, region, and Central Right-of Way offices of Department.
- C.    Accuracy: Third Order, and Class I (1/10,000).

### **3.3      PLAT COMPLIANCE REQUIREMENTS**

- A.    Utah Code 17-23-17.
- B.    Department procedure "Design Process."
- C.    Show on the survey plat:
  - 1.      Survey coordinates accurate to 5 decimal places and elevations accurate to 2 decimal places on all right-of way markers.
  - 2.      Right-of-Way markers.
  - 3.      Adjacent quarter corners and section corners.
  - 4.      Original highway control points.
  - 5.      Local city or county monuments.
  - 6.      Control line geometric information with references ties to section and quarter corners.
- D.    Compute and draw plat, stationing, and coordinates to the same units as the project drawings.
- E.    Deliver a copy of the survey plat to Engineer on a 3-1/2 inch disk in MicroStation format.
- F.    Correction Factor: Show state plane to ground correction factor.

- G. Show the latitude and longitude of the control line at the beginning and end of the project.

END OF SECTION

**Change One – August 29, 2002**

**No changes made**

**Change Two – December 19, 2002**

**No changes made**

**Change Three – February 27, 2003**

**Articles Revised**

**2.1 A, B and 3.1 A drawing number corrected**

## **SECTION 16525**

# **HIGHWAY LIGHTING**

### **PART 1      GENERAL**

#### **1.1      SECTION INCLUDES**

- A.      Materials and procedures for installing lighting for highway, understructure, sign, bridge, parking lot, and other lighting systems.

#### **1.2      RELATED SECTIONS**

- A.      Section 00727: Control of Work
- B.      Section 02741: Hot Mix Asphalt (HMA)
- C.      Section 02842: Delineators
- D.      Section 02892: Traffic Signal
- E.      Section 03055: Portland Cement Concrete
- F.      Section 03211: Reinforcing Steel and Welded Wire
- G.      Section 03575: Flowable Fill
- H.      Section 05120: Structural Steel
- I.      Section 09972: Painting for Structural Steel
- J.      Section 16135: Electrical Junction Boxes

#### **1.3      REFERENCES**

- A.      AASHTO Standard Specification Structures Supports for Highway Signs, Luminaires, and Traffic Signals (current edition)
- B.      AASHTO M 111: Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.

- C. AASHTO M 183: Structural Steel
- D. American Wire Gauge
- E. American Iron & Steel Institute (AISI) Type 201: Stainless Steel
- F. ANSI/UL 467
- G. ANSI/UL 486A
- H. ANSI 136.10, NEMA Base
- I. ANSI C80
- J. ANSI C82.4, C82.6, and C92.1
- K. ANSI/IEEE C37.13, C37.27 and C62.41; Relays
- L. ANSI C57.12.25, and C57.27 NEMA 260 (Cabinet): Substation
- M. ANSI/UL 1029
- N. ASTM A 123 (Cabinet): Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- O. ASTM A 307: Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
- P. ASTM A 570, Grade 33: Steel, Sheet and Strip, Carbon Hot-Rolled Structural Quality
- Q. ASTM A 576: Steel Bars, Carbon, Hot Wrought, Special Quality
- R. ASTM B 3: Soft or Annealed Copper Wire
- S. ASTM B 8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- T. ASTM B 117: Operating Salt Spray (Fog) Apparatus
- U. ASTM B 209: Aluminum and Aluminum-Alloy Sheet and Plate (Alloy 5052-H38)
- V. ASTM B 766: Electrodeposited Coatings of Cadmium

- W. Insulated Power Cable Engineers Association (IPCEA) Standards
- X. ITE/ANSI Lamp Codes: I, M, H, and S
- Y. NEC 250-1
- Z. NEMA 3R K91, Type HD
- AA. NEMA 3R, Type 4
- BB. NEMA FAI 1973R1979: Understructure, sign bridge luminaire
- CC. NEMA TC-2/TC-3 UL Listed
- DD. NEMA WC7
- EE. NFPA 70: National Electric Code
- FF. Standard Specifications for Construction and Bridges on Federal Highway Projects FP-92 type III Flexible
- GG. UL: Underwriters' Laboratories, Inc
- HH. UL Class CC, RK5, R, and 1572
- II. UL E-50076

#### **1.4 SUBMITTALS**

- A. Samples of all materials.
- B. Wiring schematics, detailed shop drawings, and certifications within 15 calendar days after receiving the Notice to Proceed.
- C. Manufacturer's warranties, guarantees, instruction sheets, and parts lists.
- D. List of equipment and materials including name of manufacturer, size, and identification numbers. (Within calendar 15 days after receiving the Notice to Proceed).

#### **1.5 QUALITY ASSURANCE**

- A. Electrical components must conform to the requirements of the National Electrical Code. (NEC)

## **1.6 ACCEPTANCE**

- A. Lighting Warranties and Guarantees
  - 1. The notice of acceptance for highway lighting work is not given until six months after the date of the inspection.
  - 2. During this period, all manufacturer's warranties and guarantees on Contractor- furnished electrical and mechanical equipment are enforced.
  - 3. At the end of the period and after all electrical and mechanical defects within the scope of warranties and guarantees are corrected, the Engineer makes written acceptance of the work completed and relieves the Contractor of further responsibility for that portion of the project.
  - 4. Partial acceptance does not void or alter any terms of the Contract
- B. The six-month warranty period for lighting does not affect the processing of a semi- final estimate when the Contract is 95 percent or more complete, or after completion of work on the project.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- A. Wire and Cable: As per American Wire Gauge.
- B. Conductors:
  - 1. Wire up to 600 V: Single-conductor, copper cable with cross-link polyethylene insulation per ASTM B3 and B8, RHH-USE-RHW, as specified.
  - 2. Cable above 600 V: Conform to NEMA WC7. Single-conductor, stranded copper with full concentric neutral as specified.
- C. Ground wire: Bare, soft-drawn copper wire per NEC 250-1, as specified.
- D. Ground Rod: Copper-coated steel per ANSI/UL 467, as specified.
- E. Insulation: RHH-USE-RHW grade cross link polyethylene compound.
- F. Splicing: Compression splice compatible with individual cable insulation and water seal for underground use. Comply with UL code.
- G. Conduit: as indicated.

1. Schedule 40 PVC and 80 PVC conduit and fittings rated at 200 degrees F as specified. NEMA TC-2/TC-3 UL.
2. Galvanized rigid steel conduit and fittings as specified. Meet ANSI C80.

## **2.2 JUNCTION BOXES**

- A. Refer to Section 16135.

## **2.3 POWER CABLE ROUTE MARKER**

- A. Meet ASTM B 29, alloy 5052-H38. 0.08 inch thick sheet aluminum as specified.
- B. White and red enamel paint: Refer to Section 09972.
- C. Mounting hardware: Refer to Section 05120.
- D. Flanged channel mount post: Refer to Section 02842.

## **2.4 SPLICE, MOLDED CONNECTOR, AND FUSE HOLDER**

- A. Use individually insulated and water sealed compression splice.
- B. Use spring-loaded, molded connector and fuse holder with 90 percent minimum conductivity as per ANSI/UL 486A, as specified.

## **2.5 FUSE**

- A. 600 V current limiting with 200,000 A interrupting rating. Meet UL Class CC.
- B. Light pole fuses with rating according to Table 1.

**Table 1**

<b>Voltage</b>	<b>Wattage</b>	<b>Current (Amps)</b>
120	250/400	20
208/240	250/400	15
277/480	250/400	10

- C. Lighting Circuit Fuses: Meet UL Class RK5, as specified.
- D. Service Disconnect Fuses: Meet UL Class R, as specified.

## **2.6 POLES - GENERAL**

- A. Use tapered steel poles per Standard Drawings SL 14, SL 15 and SL 17, and AASHTO Standard Specifications Structural Supports for Highway Sign, Luminaires and Traffic Signals (current edition).
- B. Galvanized per ASTM A 123, as specified.
- C. Performance criteria:
  - 1. Wind load: 80 mph wind with 105 mph gusts.
  - 2. Designed for luminaire weight of 77 lbs with projected area of 3.0 ft<sup>2</sup>.
  - 3. Maximum allowable deflection of 4-3/4 inch (Deflection criteria is based on a 100 lb horizontal load applied at 6 inches below shaft top).
- D. Pole designated for decorative lighting:
  - 1. Provide a festoon outlet located 16 ft from the base plate with duplex receptacle and weather-proof cover.
  - 2. As per UL Listed.
- E. Light Pole Numbers:
  - 1. 4 inch series C legend, green reflectorized sheeting as specified.
  - 2. Meet Standard Specification for Construction and Bridges on Federal Highway Projects, FP-92 type III Flexible.
- F. Foundation:
  - 1. Concrete: A(AE). Refer to Section 03055.
  - 2. Coated reinforcing steel. Refer to Section 03211.
  - 3. Anchor bolts: Galvanized steel per ASTM A 307 and ASTM A 123.

## **2.7 POLES - MOUNTING HEIGHT UNDER 45 FEET**

- A. Allowable stresses for steel, as specified, except increased 40 percent for Group II and Group III loading. Meet ASTM A 570, Grade 33.
  - 1.  $F_b = 21,750 \text{ psi } (0.66 F_y)$
  - 2.  $F_v = 10,900 \text{ psi } (0.33 F_y)$
- B. Breakaway base: Standard Drawing SL 15.
- C. Steel Base Plate: Type NS.
- D. Anchor bolts:
  - 1. Meet ASTM A 307 and A 123.
  - 2. Minimum yield strength of 47,800 psi, as specified.
- E. Slip bolts:

1. Cadmium-plated. Type NS.
2. With nuts and washers.

## **2.8 POLES - MOUNTING HEIGHT OVER 45 FEET (HIGH MAST)**

- A. Allowable steel stresses as specified. Meet ASTM A 570, Grade 33.
  1.  $F_b = 21,750 \text{ psi } (0.66 F_y)$
  2.  $F_v = 10,900 \text{ psi } (0.33 F_y)$
- B. Steel base-plate. ASTM A 570, Grade 36, as specified.
- C. Anchor bolts: Minimum yield strength of 55,000 psi as per ASTM A 576, as specified.
- D. High mast service hoist assembly:
  1. Head frame: zinc, electroplated with yellow chromatic dip after fabrication, and a head frame cover of spun aluminum, and with 6 each 5 inches cast aluminum hoist cable sheaves with oil-impregnated, sintered-bronze bushings with stainless steel shaft.
  2. Aircraft cables: 3 each stainless steel 1/4 inch x 3/4 inch strand (minimum 3/16 inch).
  3. Latch shaft, cam, and hardware: stainless steel.
  4. Luminaire support ring: minimum 7-gauge galvanized steel; rising rate of at least 12 ft/min.
  5. Power cable sheaves: minimum 6 inch diameter, brushed with oil-impregnated, sintered-bronze bushings with a stainless steel shaft.
  6. Centering arm: roller-contact, spring-loaded, water-resistant, non-marking roller on stainless steel shaft.
  7. Winch: worm-gear driven, self-locking, with reversing electric motor.
- E. Portable drive unit, UL Listed as heavy duty, reversing, with torque limiter, and 125 V transformer.

## 2.9 LUMINAIRE

- A. As specified, with die cast aluminum top housing, pre-wired integral ballasts with quick disconnect plugs mounted for ease of removal.
  - 1. Reflectors, sockets, mounting cradles, and clamps fitted to upper housing.
  - 2. Optical assembly: formed aluminum reflectors with a chemically bonded, non-breakable, glass finish.
  - 3. Adjustable mogul base sockets: split-shell, tempered-brass, lamp grips, free-floating, spring-loaded, center contacts, and heat- and impact-resistant glass prismatic refractors.
  - 4. Weight: No more than 77 lbs with a projected area of not more than 3 ft<sup>2</sup>.
  - 5. Mounting adjustment: Not less than 10 degrees above a horizontal position on reflector and refractor, and not less than 5 degrees of adjustment from a vertical position on the bracket arm.
  - 6. Glare shields: Steel or aluminum, when indicated on the plans.
- B. High mast luminaire: UL 1572, and as specified.
  - 1. Symmetrical or asymmetrical with the asymmetrical capable of a 360 degrees rotation.
  - 2. Cast aluminum ballast, slipfitter mounts with adjustment of at least 3 degrees.
  - 3. Optical assembly: Enclosed and filtered, with heat and impact resistant tempered glass lens.
- C. Understructure luminaire: NEMA FA1-1973R1979, and as specified.
  - 1. Specifically designed for understructure application.
  - 2. Die-cast aluminum housing, vandal-proof fastener, integral ballast.
  - 3. Optical assembly: heat- and impact-resistant, tempered glass lens, stainless steel lens guard.
  - 4. Adjustable sockets for minimum 60-degree beam angle.
- D. Sign bridge luminaire: NEMA FA1-1973R1979, and as specified.
  - 1. Die-cast aluminum housing, die-cast aluminum door and integral glare shield, single piece, closed-cell gasket. Immunity to rain and snow damage.
  - 2. 1-3/16 inch conduit clamp support.
  - 3. Refractor: shock-and thermal-resistant, borosilicate, prismatic. Designed specifically for sign illumination.
  - 4. Integral ballast.

## **2.10 LUMINAIRE BALLASTS**

- A. Meet ANSI C82.4, C82.6 and C92.1; and ANSI/UL 1029.
- B. High pressure sodium ballast.
  - 1. Power Factor: must maintain 90 percent for nominal secondary load, and a least 70 percent for any 10 percent voltage variation.
  - 2. Lamp Wattage: maintain no more than 5 percent variation.
  - 3. Regulation: maintain no more than 35 percent for 10 percent line-voltage variation.
  - 4. Must start and operate at the rated lamp wattage at ambient temperatures down to -40 degrees F for the rated life of the lamp.
  - 5. Must sustain lamp operation for a minimum of 4 seconds at a voltage dip of 35 percent.
- C. Mercury and Metal Halide Ballast.
  - 1. Power Factor: minimum of 90 percent for a 10 percent voltage variation.
  - 2. Lamp Wattage: no more than 5 percent variation.
  - 3. Regulation: maintain no more than 30 percent for 10 percent line-voltage variation.
  - 4. Must start and operate at the rated lamp wattage at ambient temperatures down to -13 degrees F for the rated life of the lamp.
  - 5. Must sustain lamp operation for a minimum or 4 seconds at a voltage dip of 40 percent.

## **2.11 LAMP**

- A. Heavy duty, long life incandescent (I) lamp, as specified. Meet ITE/ANSI lamp codes: I, M, H, and S.
- B. Phosphor-coated mercury (M) lamp that uses or has:
  - 1. Apparent color temperature of 3300 K.
  - 2. CIE chromaticity of  $X = 0.410$ ,  $Y = 0.385$ .
  - 3. Rated life of no less than 24,000 hours at 10 hours per start-up.
- C. Phosphor-coated metal halide (H) lamp that uses or has:
  - 1. Correlated color temperature of 3800 K.
  - 2. CIE chromaticity of  $X = 0.390$ ,  $Y = 0.388$ .
  - 3. Rated life of no less than 15,000 hours at 10 hours per start-up.
- D. Clear high pressure sodium (S) lamp that uses or has:
  - 1. Apparent color temperature of 2100 K.
  - 2. CIE chromaticity of  $X = 0.512$ ,  $Y = 0.420$ .

3. Rated life of no less than 24,000 hours at 10 hours per start-up.

## **2.12 SERVICE DISCONNECT SWITCH**

- A. Meet NEMA 3R K91, Type HD.
- B. 100 A Service disconnect switch with padlock, as specified.
- C. Circuit Breaker
  1. 10,000 A interrupting rating for 240 V.
  2. 5,000 A interrupting rating for 480 V.

## **2.13 CONTROL EQUIPMENT**

- A. Photocell control units.
  1. Meet ANSI 136.10, NEMA Base.
  2. Solid state photo cells that match input voltage, minimum 1800 V@ capacity.
  3. Crystal sensing devices with inverted turn-on and turn-off features.
  4. Fail safe in the "on" position. Turns on at 32 Lx " 10 percent.
  5. Dedicated, inverted, control circuits with turn-off values of 19 lx " 25 percent.
  6. Time delay range of 5 seconds to 10 seconds.
  7. Minimum 236 ft/lb metal oxide varistor lighting arrestors.
  8. Secondary sensor diodes and transient filters.
  9. Flame-retardant, high-impact covers, and acrylic windows with ultra-violet stabilizers.
  10. Clip voltage at 400 V.
- B. Lighting contactor:
  1. Hermetically sealed, steel tube mercury contacts.
  2. Manually operated, mechanically held contact.
  3. Remote, or photoelectric-operated, magnetic, electrically held contactor.
  4. Three-position slide selector with "on-off-auto" switch.
- C. Control Relay: Meet ANSI/IEEE C37.13, C37.27 and C62.41.
  1. Contact rating of 3,000 W minimum.
  2. Normally open.
  3. Multiple relay: Zinc/di-chromate-plated magnet; Class B insulation rating coil; Cadmium oxide contact, dual expulsion gap lightning arrester; valve type line arrester with no less than 650 V rating.
- D. Enclosure: NEMA 3R Type 4. Encase in a cabinet with padlock as specified.

- E. Circuit breaker UL rated at:
  - 1. 240 V at 10,000 A interrupting rating.
  - 2. 480 V at 5,000 A interrupting rating.

## **2.14 SUBSTATION**

- A. ANSI C57.12.25 and C57.27 NEMA 260 (cabinet) as specified.
- B. 480 V secondary power, IOCA oil coolant, 150 degrees F temperature rise, 60 Hz frequency, " 2 ½ percent voltage compensation taps.
- C. Foundation: Follow Standard Drawing SL 16.

## **2.15 UNDERGROUND SERVICE PEDESTAL**

- A. Meet ASTM B 117, A 123 (cabinet), UL E-50076 as specified.
- B. Galvanized Steel: Enclosure 0.12 inch, covers 0.08 inch. Meet ASTM A 123.
- C. Bottom access opening; detachable, pad mount base; baffled ventilation louver.
- D. Paint: Meet ASTM B 117. Environmental green, baked enamel over zinc-chromate primer as specified.
- E. Circuit Breaker: Main, with six space metered bus and six space unmetered bus.
- F. Meter socket with safety socket test blocks.

## **2.16 CONCRETE**

- A. Concrete: Class A(AE) per Section 03055.
- B. Asphalt Concrete: Refer to Section 02741.
- C. Flowable Fill: Refer to Section 03575.

## **2.17 HARDWARE**

- A. Screws: Stainless steel.
- B. Nuts, bolts, and washers:
  - 1. Galvanized: ASTM A 123.
  - 2. Cadmium-plated: ASTM A 165.

- 3. Type NS, as specified.
- C. Mounting bands and buckles: stainless steel, 3/4 inch wide, from 0.020 inch to 0.022 inches thick meeting AISI, Type 201.
- D. Padlock: Master, No. P-848.

## **PART 3 EXECUTION**

### **3.1 PREPARATION**

- A. Coordinate utility locations. Refer to Section 00727, article, "Cooperation with Utilities."
  - 1. Contact the appropriate power company at least 30 days before the desired connection date.
  - 2. Verify the exact location, voltage, procedures, and material required by the appropriate power company.
- B. Saw cut concrete or other improved surface that requires removal in the sidewalk area. Replace with in-kind material to match the existing grade.
- C. Load, transport and install State-furnished material.

### **3.2 POLE FOUNDATION**

- A. Construct foundation following Standard Drawings SL 14 and SL 17.
- B. Do not weld reinforcing steel, conduit, or anchor bolts.
- C. Tie reinforcing steel and conduit securely in place.
- D. Place the concrete directly into the excavation. Use minimum forming.
- E. Align and secure anchor bolts or extensions with a template.

### **3.3 CONDUIT TRENCHING**

- A. Refer to Section 02892, Part 3, article, "Trench for Conduit."
- B. Conduit offset from roadway by more than 20 ft may be installed by plowing.

- C. Installing high voltage power cable (exceeding 600 V);
  - 1. Trench should be no more than 18 inches wide and at least 3 ft deep.
  - 2. Place 3 inches of sand in the bottom of trench before installing cable.
  - 3. Cover the power cables with at least 6 inches of sand.

### **3.4 INSTALL CONDUIT**

- A. Refer to Section 02892, Part 3, article, "Install Conduit."

### **3.5 INSTALL WIRING**

- A. Refer to Section 02892, Part 3, article, "Install Wiring," paragraphs A-E.
- B. Install molded connectors on the cable so that the load side retains the fuse when it is disconnected at the cable's breakaway point.
- C. When splicing, use compression or split bolt, and waterproof as specified, meeting UL Listed.
- D. When using 600 V or higher power cable:
  - 1. Provide a manufacturer's certified plot of X.Y. partial discharge.
  - 2. Perform a high-voltage DC field test per the industry standard before connecting to the high voltage power source.
  - 3. Must meet Insulated Power Cable Engineers Association (IPCEA) standards.

### **3.6 INSTALL CONDUCTOR**

- A. Install wiring in accordance with the appropriate articles of NFPA 70. Neatly arrange wiring within cabinets, junction boxes, etc.

### **3.7 INSTALL LUMINAIRES AND BALLASTS**

- A. Immediately prior to installation, clean all light control surfaces, refractors, and reflectors to provide the maximum lumen output possible. Clean in accordance with the luminaire manufacturer's recommendations.
- B. Adjust luminaires with a level.
- C. Adjust sign bridge luminaires for optimum and uniform light distribution.

- D. High mast luminaire:
  - 1. Employ a representative from the luminaire company to optimize the light pattern.
  - 2. Obtain manufacturer's certification that the service hoist operation is correctly installed.

### **3.8 INSTALL POWER SOURCE CONNECTION**

- A. Install the grounded neutral conductor from secondary power source to the switch box.
- B. Install mounting bracket within 1 ft of both top and bottom of the switch box and within 3 ft of other cabinet or fitting.
- C. Provide and install material required by the appropriate power company.
- D. Install padlock on the switch box door and handle.

### **3.9 INSTALL SUBSTATION**

- A. Follow Standard Drawing SL 16.
- B. Locate foundation in a well-drained area.
- C. Dig a trench and backfill for the primary power cable.
- D. Install padlocks on doors.

### **3.10 PHOTO-ELECTRIC CONTROL**

- A. Adjust to "North Sky" position.

### **3.11 POLE**

- A. Follow Standard Drawings SL 14, SL 17, and SL 18.
- B. Center the shaft top over the center of the foundation after the arm extension, luminaire, and all accessories are in place or per the manufacturer's requirements.
- C. Install pole identification numbers at a 45 degree angle to approaching traffic. Remove old identification numbers without damage to galvanizing.

- D. Torque:
  - 1. Anchor bolts to 11 lb/ft.
  - 2. Slip bolts to 8 lb/ft, release, and re-torque to 6 lb/ft.
- E. When installing items on a pole:
  - 1. Do not drill steel pole.
  - 2. Use stainless steel mounting bands.

### **3.12 FIELD QUALITY CONTROL (ACCEPTANCE TESTS)**

- A. Continuity of grounding conductor to maintain 1,000 watt load at circuit ends, maintaining 95 percent of supply voltage.
- B. Test for grounds in each circuit.
- C. Insulation resistance of supply conductor to ground shall be no less than 40 MΩ (500 V megger meter test).

### **3.13 SALVAGE**

- A. Remove equipment to be reused or salvaged carefully so that it remains in the condition existing prior to its removal.
- B. Pole assembly remains the property of the Department. Transport to the location specified.
- C. Remove luminaire, arm, and conductor.
  - 1. Grease and reinstall fastener.
  - 2. Remove foundation to a depth of 6 inches below the existing surface and backfill with local material.
  - 3. Dispose of discarded junction box. Backfill with local material and compact to match adjacent area.

END OF SECTION

#### **Change One - August 29, 2002**

**Revised Articles**  
**1.6 A, B (Added)**

#### **Change Two – December 19, 2002**

**No changes made**

#### **Change Three – February 27, 2003**

**Revised Articles**  
**1.2 H**